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AN ELECTRICAL METHOD OF MEASURING THE ELASTIC LIMIT OF A METAL.

To determine the elastic limit of a metal in the ordinary way—that is to say, by observing the elongation of a sample and the corresponding stress—is difficult. If the testing machine be fitted with an automatic recorder, the curve obtained rarely shows a sharp point where the change takes place—that is, where the strain ceases to be proportional to the stress. The point can only be determined approximately by careful interpolation. Where the record is obtained from point readings it is even more difficult to get an exact determination of the elastic limit. This difficulty has led M. Guillery to cast about for more accurate means of determining this point, and he has availed himself of the change in electrical resistance which takes place in the sample during the test. This method consists in observing this change by means of a suitable galvanometer. This instrument is of the double-coil type. A current is passed through the sample under test, and by means of a shunt circuit in parallel with the sample a compensation is effected, so that the deflections of the galvanometer are not due to the resistance of the test piece itself, but to the changes in its resistance. Since these changes must depend upon the length and cross-section of the sample, any sudden change in the latter will be accompanied by a sudden change in the galvanometer deflection. An actual test of this method bears out the theoretical considerations. Plotting a galvanometer record, there is a sharp change in the curvature, corresponding to the point where the elastic limit is reached. It is further shown that by proper calibration of the galvanometer the numerical values of the various points on this curve can be determined.

This is a very pretty application of electrical measuring instruments. Not only should it be easy to apply, as there is no delicate mechanical rigging to be adjusted, but the method itself seems to possess considerable sensibility. The resistance of the sample increases both with the increase in the length of the sample and with its decrease in cross-section, making it probably a function of some power of the change in length, and therefore such change can be more easily measured than the change in length itself. It seems possible, however, that the resistance may be effected by a change in the physical state of the sample, if not, indeed, by chemical changes. These features need to be studied further, but the method may lead to important developments, and forms another interesting extension of electrical means to measuring other quantities.

ELECTROMOTIVE FORCE.

It takes a long time for those who have not been able to give up some period of their lives to close study of science to distinguish between cause and effect; and even among those whose business it is to draw this distinction, more or less confusion is frequently brought about by their dwelling upon the effect and approaching the subject from a study of this, rather than attacking the problem from the other direction. Of course, in some cases this rear attack is necessary, but after the subject has been fairly well mastered better progress may be made generally by looking at it from the other side.

The desirability of taking up the subject in this way is not always realized, and instructors are prone to treat it chronologically rather than logically. They, for example, talk about

an experiment with currents, directing the student's attention to them, and only after he has more or less familiarized himself with phenomena accompanying an electrical flow do they suggest to him the idea of electromotive force—of that which causes the current to flow. He has already grasped the idea of a difference of potential, and the new term at first seems unnecessary. How many of us have not been in this condition, when we first took up the study of electricity, and complained that the distinction which it was sought to draw was too fine; that the current flowed because there was a difference of potential, and that it was not necessary to go back of this idea. Of course, further reflection or still further study demonstrated how impossible it would be to talk or think clearly on electrical matters if no such distinction were made. The mere introduction of a new term does not carry us any nearer to the ultimate explanation of things, but it helps to a clearer understanding and easier exchange of ideas.

This difficulty in appreciating what is meant by electromotive force—that is to say, the cause of an electric flow—is frequently met with in discussions of a more or less popular kind in which the term seldom appears. Probably, as a general rule, no harm is done, particularly if the omission be not too glaring; but, on the other hand, the idea of this force is often essential to the proper understanding of the subject. This is true in discussions of behavior of electrical machinery of all kinds, and particularly so when the apparatus being considered is a motor. We may talk about the performance of a dynamo fairly satisfactorily if we state merely that the driving around of the armature causes a current to flow; but when it comes to an examination of the performance of a motor we soon get into trouble if we do not explain clearly that the very motion of the armature of the motor sets up a force which opposes the flow of current through it.

No work can be done unless we overcome some force. In the dynamo we may say that the current flowing through the armature resists its rotation. But what resists the flow of current through a motor's armature, and what controls this rate of flow? These are questions which meet one at the very outstart, and until some satisfactory explanation is adopted no intelligent progress can be made. If the student will bear in mind Faraday's laws governing the action of a magnetic field on a conducting body—that is to say, that relative motion will set up an electromotive force, a force which tends to cause a current to flow; and Lenz's law, which is really a corollary of the law of the conservation of energy, that the reaction of an effect opposes the cause, he should have little trouble. When a current is allowed to flow through a dynamo armature, the magnetic forces set up by it oppose the mechanical motion; so, in a motor, if the armature be allowed to revolve when a current passes through it, this motion will set up an electromotive force which will oppose the flow of current—the so-called counter-electromotive force. A dynamo is a source of current, hence the electromotive force set up in it acts with the current. A motor is a consumer of electrical energy, therefore the electromotive force set up in it must oppose the current flow. These relations seem simple enough, yet almost every day one meets with evidence that they are not understood.

TELEPHONES IN RAILWAY WORK.

It was not many years ago that the availability of the speaking telephone as an adjunct to the Morse telegraph system in the despatching departments of great railroad systems was looked upon with considerable skepticism. The trained operator and ever-careful despatcher held that there was too much danger in a misunderstanding of the spoken words, and that, in the hurry and enthusiasm of a direct conversation, mistakes might be made which could only result in disaster. The practice of transcribing into long hand and recording permanently upon data sheets telegraphic communications seemed to indicate an almost infallible system—one which was surely very much more secure than that which depended upon the retention in one's mind of the spoken message. The telegraph, it was held, reduced matters to a nicety, and whatever message there was to be transmitted, conciseness and directness were essential characteristics.

To-day, however, the telephone is a recognized factor of considerable importance on more than one large system of steam railroads. While it is not entering very largely into the despatching department, it is almost universally used for intercommunication between railroad officials, freight agents, division superintendents, and between the public and all of these different departments. It is a matter of fact, also, that in many emergencies the telegraph system is almost wholly cut out and the communication established over telephone lines. In a recent issue of the *Railway Age,* the telephone equipment of the Burlington system is described. The Burlington system is operated under two grand divisions—the lines east of the Missouri, with headquarters at Chicago, and the lines west of the Missouri, with headquarters at Omaha. Each grand division is controlled by a general manager, reporting to the vice-president. The grand divisions are each further separated into semi-grand divisions under the control of division superintendents. There are four private branch exchanges in Chicago connected with exchanges at Aurora, Galesburg, Burlington and West Burlington. For the most part the lines are full copper metallic circuits, the copper wire weighing 210 pounds to the mile. This copper circuit is quadruplexed—that is to say, in addition to the telephone circuit it also furnishes a "quad" telegraph circuit. Besides the copper circuit there is, between Chicago and Aurora, an iron circuit which carries a standard composite equipment giving a single telegraph circuit for each wire of the pair, and a telephone circuit over the pair of wires, making three available circuits from a single pair of wires.

The officials of the traffic department are in regular communication with the local men of the department with regard to securing business, and information of this kind can be obtained by conversation over the telephone, where, by telegraph, considerable correspondence would be necessary and much delay experienced. The question of supplies is an important one, and

in the handling of merchandise orders this can be done to much greater advantage by telephone than by telegraph.

The operating department makes use of the circuits, especially in that the Chicago despatcher can arrange freight service with division points. In this class of service the railroad can not arbitrarily run regular trains, but must arrange the service according to the business in sight. Trainmasters and despatchers regularly twice a day discuss these questions and arrange their business accordingly. It is stated that by the use of the telephone on this division the road saved running ten train crews over a considerable distance in one month. This meant quite a saving in cash.

Many other uses of the telephone for railroad service could be mentioned. The addition of the telephone circuit along the right of way makes available the use of a portable telephone set carried upon the train. In many instances the conductor has been able, by hooking in, to get in communication with the despatcher's office and run around an obstruction, when, if the telegraph alone were available, he would have had to wait for orders from the nearest point at which a telegraph office was located. Again, in case of accident, the telephone may be used with distinct advantage, in that details can be properly attended to which, with telegraphic communication, would involve a very much greater length of time and the ever-present possibility of unfavorable consequences.

THE AGENTS OF TRANSPORTATION.

Human progress has always depended upon an exchange of ideas or things. First, language, spoken and then written, developed the mind, and then the exchange of material possessions improved man's physical condition. No man can improve his mind by mere contemplation, nor can he make much progress materially without intercourse with others; nor can any community make more than a little growth if it shuts itself in and refuses to have dealings with its neighbors. One would not expect great wealth to develop in the Scotch village, the people of which are said to live by taking in each other's washing. Throughout all history the great civilizing and developing agent has been commerce, both in ideas and in things.

This idea has been slowly recognized. Those nations first to grasp it always forged rapidly to the front. At first commerce was more or less adventitious. The greater burden of it was carried on by water. Travel by land was too painful and uncertain. Even until what may be called recent times we were wont to depend upon water for transporting goods. If the place to be reached were not on the sea or on a navigable river, a canal was dug. Roads in those days were not constructed for such purposes, and thus sites possessing great material advantages for making certain articles were unavailable. There was no way of disposing of the products, even though they could be made easily; and the mere fact that a certain locality possesses unsurpassed advantages for making some article is of little value if there be not some way of disposing of it; for, as said before, no community can rise high from simple internal trading; it must take advantage of its superior facilities, for which others pay, and it must also be ready to grasp the advantages possessed by other communities, for which advantages it must pay. To meet this need various methods of transportation have been devised, but, until the introduction of the railroad no very great progress—that is to say, as compared with present-day conditions—was made. In fact, to-day it is safe to say that the welfare of a nation depends upon its commerce, and commerce depends upon the means of transportation.

But of late years a large commerce has grown up in things not material. The railroads have given us a method of transporting matter. Now we have developed a need for transporting energy. Perhaps the development may have been brought about in the reverse order, and the offering of the means for transporting energy has made available large resources hitherto unattacked. However the matter may be viewed, the condition is the same, and an essential of industry to-day is cheap energy.

Now, in the field of manufacturing energy, or, rather, of converting energy into salable form, certain localities possess great advantages, but to dispose of their wares they need a means of transportation. Until recently this was done painfully, and over short distances only, by means of ropes or some other crude method. Even to-day our main dependence may be considered a makeshift. We transport our fuel at great cost in order to obtain the necessary power at the point where it is needed. During the last ten years a means of transporting energy has been developed which may fairly be compared with the development of the railroad. Electrical transmission makes easy the production of power at one point and its delivery at the point where it is to be used. It is rapidly becoming to commerce in energy what the railroads are to commerce in material; and just as the welfare of a country is dependent upon its commerce, so its industries are dependent upon the production and distribution of power. These two agents of transportation—the railroads and electrical transmission—are therefore two of the most important fields to be carefully developed in every community. At the present day, measured by the standard of capital invested or of work done, the railroads are, of course, much the more important; but electrical transmission, in some form or other, touches us individually more closely, and, indeed. the railroads of the future may become absolutely dependent upon it. The one is the means for transporting matter; the latter the means for transporting energy. Both ultimately will be equally important.

The central station manager who devotes some thought and work these summer days to cleaning up and repairing his machinery will find the time and labor well spent. There has been a great improvement in the appearance of large lighting stations during the past few years, but this excellent cleanliness and care has not been so fully extended to the smaller stations. Every manager should take especial pride in making his place attractive and comfortable, by concealing all scraps, by having well scoured all bright metals and in maintaining a general inspection of all physical parts of the plant under his care.

THE DESIGN OF BLAST-FURNACE GAS ENGINES IN BELGIUM.[1]

BY H. HUBERT.

The first attempts at direct utilization of blast-furnace gas in engines were made in 1895. For a considerable time the gas had been burnt in Cowper stoves for heating the blast for the furnace, and under the boilers which supplied steam to the blowing engines, and others serving the furnaces. It was natural, therefore, that the idea of directly employing it in gas engines should have occurred simultaneously to several engineers, notably to Lürmann and to Lencauchez, who had pointed out the blast-furnace as a powerful gas producer. Nevertheless, nowhere had any attempt been made to apply it to this purpose up to the end of 1894, when Thwaite proposed it to James Riley, of the Glasgow Iron and Steel Company.

About the same time investigations were being made in Belgium and in Germany, independently of Thwaite's experiments, which were not generally known on the Continent.

The industrial world, which up to that time had hardly favored the idea, had thus been gradually prepared to receive it. The gas engine, long restricted to small sizes and dependent upon the use of an expensive fuel obtainable only in large centres, now began to make headway.

At the Paris Exhibition of 1889, two engines of 100 horse-power were shown, and excited much interest amongst engineers. One had four cylinders, and was made at the celebrated works of the Deutz Company, and the other was a single-cylinder engine, exhibited by two French designers, Messrs. Delamare-Debouteville and Malandin.

In the meanwhile the design of gas producers had made important progress, completely freeing the new engine from its dependence on the gas works, enabling it to be installed anywhere, and to realize to the full extent its economic value by supplying it with a cheaper fuel.

In 1892 Delamare installed at the Moulins Leblanc works, at Pantin, a four-cycle, single-acting, single-cylinder engine, using producer gas, and developing 220 brake-horse-power, with a consumption of about one pound of coal per brake-horse-power per hour. Despite the difficulties met with in this bold attempt, it showed the possibility of economically producing high power with poor gas.

The time had now arrived for engineers to pay attention to the use of gas from blast-furnaces, which, although not of great heating value, was less costly, and was the more suitable on account of the progress which had been made in the design and working of blast-furnaces, the proportionally lower consumption of coke, and, as a result, the marked reduction in the relative quantity of combustible gases, which only sufficed, with difficulty, to heat the blast and to produce the steam required about the furnaces. Finally, the progress of the science of heat had brought to light the causes of the low thermal efficiency of the steam engine, and notably of the loss resulting from the employment of boilers.

It is not therefore surprising that the idea of dispensing with the boiler, and burning the blast-furnace gases directly in the engine, occurred nearly simultaneously in three countries, where metallurgical industry had made great progress.

To Bailly and Kraft, of the Cockerill Company, belongs the honor of being the first in the field in Belgium. The patent taken out by the Cockerill Company for this new application was dated May 15, 1895, and the first trials were made at the end of that year. They were made with a "Simplex" engine of eight horse-power, in which it had only been sought to reduce the clearance space, in order to increase the compression and to facilitate the ignition of the mixture. The gas cleaning was very imperfect, and was carried out simply by passing it through two scrubbers four metres in height.

This engine displayed perfect elasticity and adapted itself to the variations of composition, pressure and temperature of the gases, giving an efficiency of 77 per cent.

The authors, in an article published in the *Annales des Mines de Belgique* at the commencement of 1897, described the results of the first trials, and the conditions necessary for the direct use of blast-furnace gases, showing that a plant producing 100 tons of pig per day was able to furnish about 18,000 cubic metres of gas per hour with a calorific value of 1,000 calories. Taking into consideration that half this volume is available, and allowing for an efficiency of only twenty per cent in the engines, the authors showed that it would be possible to obtain from these gases about 3,000 horse-power.

The small trial engine consumed about five cubic metres per brake-horse-power, which reduces the preceding figures to 1,800 horse-power; but they foresaw at the time that this consumption would be ere long greatly reduced, and that blowing engines driven by gas would be built. They also foresaw that, by disposing of the great surplus motive power, the blast-furnace would ultimately become a centre for the production of energy for works surrounding, the boilers of which it would gradually supersede.

This remarkable progress was described by E. P. Martin, president of the Iron and Steel Institute, in his presidential address of 1897.

At the meeting of the institute on May 3, 1898, M. A. Greiner discussed the results published up to that time, which included the author's paper of February, 1897; a note by Galbraith and Rowden on November 18, 1897; one by Lencauchez on November 8, 1897, and another by Lürmann on February 27, 1898.

Mr. Greiner combated the objections which had been specially raised against this new method of employing gas by German metallurgists at the Düsseldorf meeting, and gave reasons for his belief that the consumption would be reduced below four cubic metres per brake-horse-power per hour, and that the blast-furnaces would be able, by superseding the steam boiler as an intermediary in the production of motive power, to place at the disposal of the engineer twenty horse-power per ton of pig produced daily.

Experience soon verified these forecasts. The Cockerill Company have constructed, with the collaboration of Mr. Delamare, a four-cycle, single-cylinder engine of the "Simplex" type, which in the twenty-four-hour trials, at which the author had the honor to collaborate with Professor A. Witz, gave one brake-horse-power for an average consumption of 3,329 cubic metres, of a gas possessing a calorific power of 981 calories—say, 3,266 calories. (This figure has since been reduced to 3,162.)

The principal dimensions of this engine are as follows:

Diameter of cylinder.....	0.800 metre
Stroke of piston.....	1 metre
Revolutions per minute....	105
Indicated horse-power.....	213
Brake-horse-power.....	182

The construction of this engine is worthy of note. The cylinder proper is cast with a breech carrying at its lower portion the exhaust valve, and at the back a cylindrical prolongation, in which the admission valve is placed. This breech or cylinder head has its own water jacket and is provided toward the front with flanges bolted to the cylinder jacket, which was a part of the cylinder bayonet casing.

The shaft is not cranked, and carries a heavy flywheel. The piston is made in one piece and is not chilled. The pressure does not exceed seven kilogrammes (100 pounds). The sparking is effected by Delamare's system, in which a succession of sparks, produced by a Ruhmkorff coil,

[1] Paper read before the Iron and Steel Institute, July 24, 1900.

is emitted from a slide-valve on the back of the cylinder when its opening comes opposite to an orifice bored in the back. The movement of the sliding valve and similarly of the other valves is made by a crank and by cams keyed on to an auxiliary shaft parallel to the cylinder and revolving at half the speed of the main shaft. The governing is effected by the hit-and-miss arrangement by means of Delamare's air governor.

Starting is effected by turning the flywheel by a handwheel and by admitting a charge of carbureted air the explosion of which starts the engine.

The success of this engine, which worked perfectly without the gas being cleaned as effectively as is now done, and is still running after being eight years in service at Cockerill's, encouraged them to build a much more powerful type of engine, capable of directly operating a blowing apparatus of 600 horse-power, and consequently of liberating the blast-furnace from its dependence upon the boiler.

Though the enterprise was considered rash, they still went on with the attempt, which was logically justified, seeing that in modern steam-driven blast-furnace installations the gas produced is only just sufficient for the requirements of the furnaces. To procure gas in excess it was necessary to commence by replacing the existing engines by the more economical gas engines, for by such means only would gas be available. It is necessary to commence with gas-driven blowing apparatus. A motor of this description attracted much attention at the Paris Universal Exhibition of 1900. Another, coupled with its blowing apparatus, in the blast-furnace department of the Cockerill Company, and started up on November 20, 1899, was submitted to a series of trials on March 20 and 21, 1900.

The features of this remarkable engine were as follows: regulation by the method of hit-and-miss—that is to say, suppression of an admission of gas complete.

By Brake Tests—		
Diameter of cylinder.....	1.800 metres	
Stroke of piston.....	1.400 "	
Revolutions per minute....	94.4	
Indicated horse-power.....	786	*
Effective brake-h-p.....	575	*
Consumption per indicated h.-p.-hour.....	2.556 cubic metres, or 2,515 calories.	
Consumption per brake-h.-p.-hour.....	3.495 cubic metres, or 3,440 calories.	
Tests with the Blowing Apparatus—		
Number of revolutions per minute.....	93	
Indicated h.-p.....	886.5	†
Effective brake-h.-p.....	725	†
Consumption per indicated h.-p.-hour.....	2.334 cubic metres, or 2,343 calories.	
Consumption per brake-h.-p.-hour.....	2.853 cubic metres, or 2,864 calories.	

* With 89 per cent admission and 11 per cent hit-and-miss by the governor.
† Full charge without hit-and-miss.

The method of construction of the 200-horse-power motor had generally been retained, saving that the main bearings were separated from the cylinder casing, and were connected by four strong screwed steel stay-bolts, giving easy access to the piston. The shaft was cranked and rested on three bearings to support the flywheel, which weighed thirty-three tons. The piston-rod traversed the back cover in a stuffing box.

The admission valves were retained below like those of the exhaust. The admission of gas was carried out by separate valves placed in a valve box, separated from the cylinder by a third valve, called the mixture valve. The methods of working the valves and those of the ignition slide valve were retained. The regulation was carried out by hit-and-miss. The pressure attained nine kilogrammes per square centimetre (128 pounds). The circulation of water extended to the head and to the piston rod itself, to which the water penetrated by means of flexible pipes, which adapted themselves to its movement. The exhaust valve was also cooled. This was done with the object of preventing the ignition of the mixture by the dust, which, combining with the products of the decomposed oils on the piston or in the recesses of the explosion chamber, might form concretions retaining a temperature high enough to ignite the gases.

The arrangement of all the valves at the under side of the cylinder was such as to facilitate the sweeping out of the dust and decomposed oil, and to allow these large engines to work equally as well as the 200-horse-power engines without having recourse to a more perfect gas-cleaning process. This hope was ill-founded. It became necessary to interpose between the blast-furnace and the large engines of this class apparatus capable of reducing the dust held in suspension by the gas to 0.02 gramme per cubic metre. The means now used in Belgium are centrifugal fans with water injection and Theisen, Brian and Zschokke apparatus. The latter are not, strictly speaking, purifiers; they are, rather, coolers.

As they are not the invention of Belgian engineers, and as they will be made the subject of another paper, it is not necessary to deal further with them.

As is well known, the novel idea of the Cockerill Company was vigorously discussed by engineers, who saw therein an economic mistake, and maintained that it was better to divide the power between two or four cylinders. The designers, nevertheless, knew perfectly well that they could obtain in this way, for a 600-horse-power engine, a more regular and perhaps more economical engine. They had already, however, studied the two-cylinder tandem types of 600 and 1,200-horse-power. One of Cockerill's licensees—Brietfeld-Danek, of Prague—had, since 1901, constructed a four-cylinder double-tandem engine of 600 horse-power, giving remarkable even running; but Messrs. Cockerill wished to demonstrate that it was practically possible to develop 600 horse-power by means of a single cylinder alone, single-acting and of four cycles, and consequently to construct engines developing up to 2,500 horse-power without exceeding four cylinders. In addition to this they were, moreover, anxious also to improve the governing, by applying to these large engines the principle of variable admission in lieu of the hit-and-miss governing, which required the use of heavy flywheels, and was not well suited for producing alternating electric currents, and needlessly strained the engine when it had to run continuously with reduced loads.

From 1901 they realized, with M. Delamare, that it was essential to obtain a variable-admission motor, an air governor, or else a centrifugal force, causing the double air and gas valves to open from the commencement of the suction stroke, but determining the closure earlier in the stroke as the power to be developed becomes lower.

In this manner the mixture admitted possessed the composition most favorable for complete combustion, but the volume admitted to the cylinder varied, and with it the pressure.

The ingenious mechanism which realized this mode of operation, which has been described elsewhere by the author,* was applied to a single-cylinder motor of 200 horse-power of the same dimensions as that of 1898.

The trials to which it was submitted in November and December, 1901, established beyond doubt a consumption varying between 3.318 and 3.455 cubic metres per brake-horse-power per hour for full load, the calorific value being 914 to 1,017 calories. The expenditure in calories per horse-power varied between 3,172 and 3,434, and has been on an average nearly 3,298—practically the same as that of 1898. At half-load it was on an average 4,320 calories, and at quarter-load 7,406 calories.

About the same time (1902) the Cockerill Company produced another engine, designed to give greater regularity with

* *Revue Universelle des Mines*, 1902, vol. lix.

smaller dimensions—*viz.:* the double-acting engine.

It was well known that the first industrial gas engine—that of Lenoir—was double-acting, but the success of the Otto four-cycle and single-acting engine had, for a long time, relegated to the background all other types of engines. Nevertheless, M. Letombe, at the Brussels Exhibition, showed a four-cycle and double-acting engine.

The Körting Company exhibited at Düsseldorf a powerful two-cycle double-acting engine which attracted much attention. The long-standing prejudice against the adoption of this system was thus broken down.

The direct driving of the blowing apparatus from the piston rod of the engine had accustomed Cockerill's engineers to the adoption of a stuffing box at the back end of the cylinder. They were therefore naturally disposed to adopt double action, which enabled them to considerably reduce the size of the cylinder, and consequently approach large powers more easily, thus ensuring more steady running with a lighter flywheel.

They retained, firstly, the general arrangement of the single-acting motor, which up to that time they had constructed, notably the disposition of the inlet and exhaust valves underneath the cylinder. However, from that time they introduced an important modification. The cylinder liner with its jacket constituted a part independent of the two cylinder heads. Each of these carried a stuffing box, through which the water-cooled piston rod worked, and an extension downward of the combustion chamber, in which were installed the valve, which simultaneously admits air and gas, and actuates the exhaust valve. The actuating mechanism of the valves was also modified, without departing from the system of variation of the admission, consisting of cutting off the air and gas supply simultaneously. This system had the advantage of preserving the composition of mixture most favorable to complete combustion, but it had the inconvenience of diminishing to some extent the compression as the charge decreased. This diminution reduced the economic efficiency of the engine in the case of light loads; and also when it happened that the gas was very poor it spoilt the ignition and caused misfires, which altogether upset regularity and economy.

This trouble becomes very marked in motors driving dynamos, which very often work with reduced loads, and where economy is a greater consideration than in blowing engines. Therefore, no time was lost in introducing another system of variation, consisting of air admission to the cylinder during the whole piston stroke, and only allowing the gas to enter during the last portion of the stroke by the governor varying the moment at which this admission commences. In this way invariable compression is secured.

It is true that when the mixture is modified it becomes poorer and poorer; but it should be noted that gas is introduced at the back end of a cylinder already partially filled by a volume of air which follows the piston. Although it is impossible absolutely to rely upon retaining the exact stratification characteristic of the Otto cycle, there persists, nevertheless, an undoubted statification of mixture, the richest strata remaining at the back end of the cylinder, close to the ignitor.

The sparks then impinge on the explosive mixture, which, being strongly compressed, ensures that the ignition is readily transmitted to the whole volume. It will be seen that the gas-admission valve must be able to open independently of that giving air admission.

In engines of this system the two valves are superposed, the air arriving by a casing which surrounds the gas passage, and the valve spindle passing through the gas valve, which is hollow. The placing of the valves in an ante-chamber of the combustion chamber, leading to a tubular combustion chamber, evidently assists the stratification of which mention has been made, and consequently, the ignition of weak charges, but it resulted in cylinder heads of unsymmetrical form, which created difficulties at Cockerill's works, as it had already done elsewhere.

The unequal contraction of the metal of the various parts of the cylinder head caused great stress, which, added to the already high stresses, due to the explosion and to the heating, have occasionally brought about the fracture of the cylinder heads, even when they have been replaced by steel castings.

This circumstance decided the makers of large engines to revert to the symmetric arrangement of the valves, which is customary in steam engines where the inlet valve is placed on the top of the cylinder, and that of the exhaust underneath, and thus to obtain an arrangement which lends itself well to expansion, and which, moreover, facilitates access to the valves.

This arrangement has been obtained in different ways by manufacturers, notably at the works at Deutz and Nürnberg and at Seraing. At the Cockerill Company's works the covers are no longer attached to the central body by studs screwed into it, but joined by tie-bolts bolted to flanges on these covers.

These bolts are thus subjected to tension, and, similarly, the body of the cylinder is subjected to a compression stress of the kind which best suits such metal. This arrangement is patented. The frame is formed of two box girders carrying the cylinder. These girders are joined by tie-bolts to others that contain the slides and carry the crank-shaft bearing. The piston is composed of two halves with double walls, each half permitting water circulation, the two halves being bolted together with an india-rubber joint.

The water cooling is effected at a pressure of three and one-half to five kilogrammes (fifty pounds to seventy pounds) per square centimetre, to avoid water-hammering in the piston and its rod. The water, furnished to the latter by a duct fixed at one end, passes through the rod and the two halves of the piston, and goes out at the back by another duct.

The ignition is effected by means of one or two high-tension magnetos, through fixed sparking-plugs. These magnetos do away with the necessity for a source of electricity external to the motor. The compression has been successively increased up to fourteen kilogrammes per square centimetre. The starting is effected by means of air, compressed to ten atmospheres (143 pounds) by a special compressor, and retained in a reservoir in sufficient quantity to enable the engine to revolve several times.

KJELLIN ELECTRIC STEEL FURNACE.[1]

BY E. C. IBBOTSON.

This process was reported upon by the Canadian commission in 1904, and much detailed information was also given in a paper by Chief Engineer V. Engelhardt, published in "Stahl und Eisen."[2] Believing that some of the latest particulars of the process will be of interest, the author submits the following data:

At Gysinge, in Sweden, during the year ending May 31, 1906, from a fixed furnace giving one ton (2,240 pounds) of steel per tap, there were produced 950 tons of tool steel and special steel ingots. In carbon and iron tool steels all the usual tempers were made. The bulk of this steel was made from charges composed of about

[1] Paper read before the Iron and Steel Institute, July, 1906.
[2] Vol. xxv, 1905, Nos. 3, 4 and 5.

eighty per cent of Swedish white pig iron and twenty per cent of steel scrap. The percentage of carbon was regulated by the addition of briquettes. Other charges were made from Swedish white iron and steel scrap.

The average time taken per charge for the year, when adding briquettes, was seven and one-eighth hours, and the electric energy consumed was 1,128 units (kilowatt-hours) per ton. The average time per charge for white iron and scrap charges was five and one-half hours and the electric energy consumed was 886 units per ton. These consumptions include all time and energy lost from various causes, such as bad water supply, ice, etc.

It is quite ordinary practice to complete the charges with briquettes in six and one-half hours, and without briquettes in five hours, as shown by the following typical charges: white pig iron, 1,457 pounds; steel scrap, 439 pounds; briquettes, 220 pounds; ferro-silicon (fifty per cent of silicon), seventeen pounds; ferro-manganese (eighty per cent of manganese), fifteen pounds; aluminum, one ounce.

The times, strength of current and units consumed for this charge were as follows:

Time.	Current.		
	Kilowatts.	Units.	
5.30	125	.....	Charging two-thirds of the pig iron.
6.00	145	67.50	
6.30	160	76.25	
7.00	170	82.50	Charging the remaining one-third of the pig and the scrap.
7.30	170	85.00	
8.00	165	83.75	Clear melted.
8.30	165	82.50	Briquettes added.
9.00	165	82.50	
9.30	165	82.50	Briquettes added.
10.00	165	82.50	
10.30	165	82.50	Briquettes added.
11.00	165	82.50	
11.30	165	82.50	
12.00	130	73.75	Ferro-silicon and ferro-manganese added. Tapped.
6½ hours.	...	1,046.25	

The chemical composition of the materials charged and of the resulting steel were as follows:

WHITE IRON (HERRANG).

	Per Cent.
Total carbon	4.00
Silicon	0.15
Manganese	0.18
Sulphur	0.010
Phosphorus	0.012

BRIQUETTES.

	Per Cent.
Iron	59.0
Sulphur	0.010
Phosphorus	0.006
Silica	11.00
Lime (CaO)	2.50
Alumina	0.50

STEEL INGOTS.

	Per Cent.
Carbon	0.40 to 2.00
Silicon	0.12
Manganese	0.34
Sulphur	0.012
Phosphorus	0.014

The lining of this furnace during the year was magnesite. When using briquettes the lining lasts, on an average, five weeks, and when charges are worked without briquettes the average life of the lining is seven weeks.

Various tests have been made of the steels produced in this furnace, and many have been given in previous reports. During the year satisfactory results obtained in works practice have been reported, particularly in connection with the following steels: stamping dies, punches, cold chisels, screwing dies and taps, cutlery, drills and turning tools. The following special steels have also been produced: Tungsten steel (including permanent magnet steel), chromium steel, nickel steel, nickel-chromium steel, self-hardening steel and high-speed tool steel. High-speed tool steel, tested to one of the latest government specifications, gave satisfactory results, while twenty-five per cent unannealed two-inch nickel steel bar, one-half-inch diameter, gave a yield point of 30.68 tons per square inch, a maximum stress of 50.44 tons per square inch, an elongation of forty-four per cent, and a reduction of area of sixty per cent.

Electrical tests carried out have shown that No. 6 gauge rods had a specific resistance of thirty-six microhms per cubic inch; No. 16 gauge wire a specific resistance of 33.5 microhms per cubic inch.

Edgar C. Bradley Joins the Staff of the American Telephone and Telegraph Company.

Edgar C. Bradley has resigned as second vice-president of the Postal Telegraph-Cable Company to accept a leading executive position on the staff of Frederick P. Fish, president of the American Telephone and Telegraph Company.

Mr. Bradley was born at Portland, Mich., November 16, 1855. At the age of fifteen, he entered the service of the Michigan Central Railroad Company as telegraph operator. He became connected with the Pennsylvania Railroad Company in 1877, and in 1888 was appointed superintendent of telegraph of the entire Pennsylvania system west of Pittsburg. Four years later he became assistant general manager of the Postal Telegraph-Cable Company with headquarters at New York city, rising later to the position of vice-president. He has had general charge

EDGAR C. BRADLEY.

of the lines and physical property of the company, supervision of requisitions for supplies and various other details connected with this great network of lines of communication.

For the next three months Mr. Bradley will make his headquarters at San Francisco, where he will assist in the rehabilitation of that part of the telephone system destroyed by the recent earthquake and conflagration. Mr. Bradley is one of the ablest telegraph men of the day, and his genius has been responsible for a great deal of the development which has come about in this industry. His affiliation with the American Telephone and Telegraph Company will surely be productive of much forward work, and his enterprise can be counted upon to make him of progressive value to his new field of endeavor.

The Hydroelectric Plant at Lucerne, Switzerland.

By Franz Koester.

THE city of Lucerne, the capital of the canton by the same name, the city most frequented by tourists in Switzerland, has lately installed its own power plant to supply light and power to the city itself, as well as to the Stausstad-Engelberg Railway, water power from the Erlenbach by Engelberg having been utilized, a company being formed in 1903 in which the city of Lucerne holds ninety per cent of the stock.

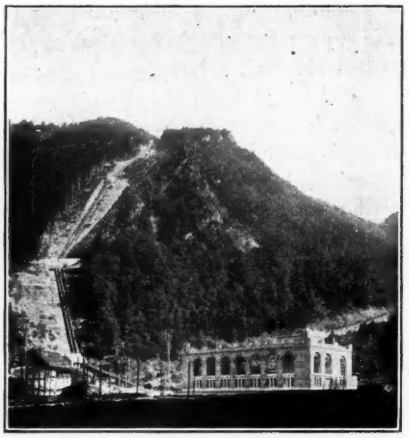
As the river gives a water supply of some 1,000 litres per second (thirty-five cubic feet), and as the head is 1,023 feet, some 8,000 to 10,000 horse-power is available; this, however, is figured on the operation of the plant for twelve hours per day; but, taking into consideration the number of small mountain streams which may easily be turned into the river, a still greater horse-power is easily obtainable should occasion demand.

A short distance from where the spring emerges from the mountain a channel 259 feet in length diverts its course to a natural reservoir which has a capacity of 2,471,000 cubic feet.

The water of this spring is always at the same temperature and particularly free from sand. The flow is greater in summer than in winter, but the needs of the plant are met exactly, as in the summer season there are greater demands made on the plant, due to the increase in traveling. From the natural reservoir a tunnel leads to a concrete collecting basin twenty-three feet square. The tunnel, which is 8,480 feet long, has a cross-sectional area of forty-five square feet and runs on a slope of 1.2 feet per 1,000. The concrete collecting basin is designed to accommodate four penstocks, only two of them being at present in place, and is well provided with sluice-gates, screens and overflow. The penstocks have a diameter of 3.28 feet, are 2,025 feet long, and are made of riveted steel plates in sections twenty-six feet long. They are anchored by heavy concrete blocks at five points, as may be seen in the accompanying illustration, expansion being allowed to take place in an upward direction, the lower end being anchored and the upper end provided with an expansion joint.

At the side of the power-house, before the penstocks branch to the water-wheels, they are each provided with a butterfly valve, and two safety valves are placed on the end of each penstock, by which also the entire penstocks may be drained, the water flowing in the tail-race to river Aâ.

The main generating room is 177 feet long, 43.6 feet wide and thirty-nine feet high and is directly in front of the switching house, separated from it by heavy pi-



LUCERNE HYDROELECTRIC PLANT. COLLECTING BASIN, PENSTOCKS AND POWER PLANT.

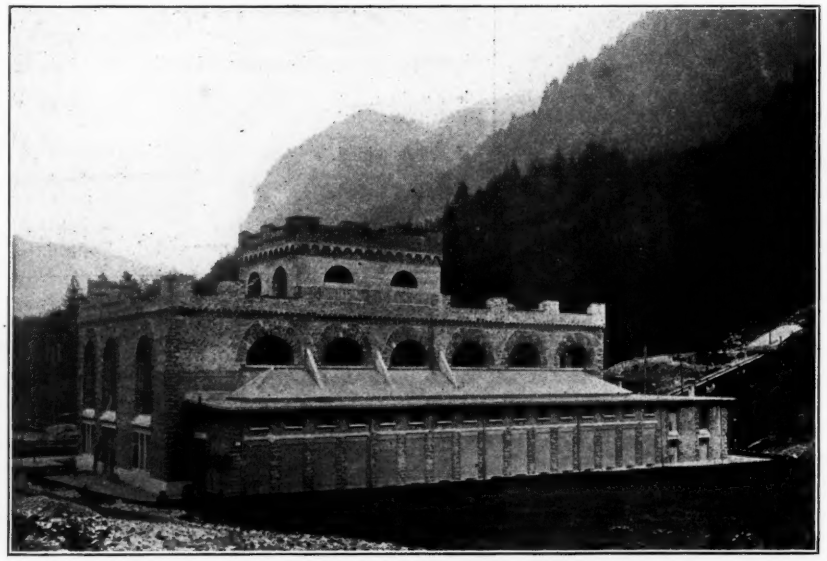
lasters upon which travel a thirteen-ton electrically operated crane. Behind the switching house is the transformer annex, another small annex being devoted to the storage-battery room and offices.

The architectural features of the inside of the building are pleasing, while those of the outside harmonize well with the surrounding country. The building, of rough-faced stone, reminds one of the old Swiss strongholds and castles, although it does not lose its identity as a power plant. Large arched windows are provided, furnishing plenty of light for the generating and switching rooms.

The plant is designed to accommodate six 2,000-horse-power Pelton wheels, direct-connected to the generators. There are, however, only four main units installed. These Pelton wheels, operating under a head of 1,023 feet, make 300 revolutions per minute, and are well equipped with automatic and hand-regulating apparatus and hydraulic servomotors.

The plant supplies light and power to Lucerne, which is distant seventeen miles, and Engelberg, nine miles, besides supplying some 200 kilowatts to some fifteen villages at canton Uid and Obwalden. One generator of 600-horse-power capacity is held in reserve that it may be thrown in parallel with the generators of the Stausstad-Engelberg Railway power-house when needed.

There are two distinct bus-bar systems—one a single-phase system, for the lighting of Lucerne; the other bus-bar supplying all other light and power. There is an additional plant in the Thorenberg which in the future is to become a reserve for the single-phase system of lighting at Lucerne, the light and power for the smaller towns and villages being taken off the three-phase lines, as the variations in the load are not great enough to seriously interfere.



LUCERNE HYDROELECTRIC PLANT. POWER-HOUSE, SHOWING TRANSFORMER ANNEX.

There are four single-phase—three-phase generators of 2,000 horse-power each, which may be thrown either on the

lighting or power system, the connections for these being separated from those of the 600-horse-power railway generator referred to above, with the exception of the exciting system, which is common to all. The exciters consist of two 100-kilowatt generators, only one of them being used at a time, this generator also supplying the current for the lighting of the power-house, working the signal system, and for the small motors which operate the high-tension switches. A storage battery is placed in the exciting circuit. The bus-bar circuits are constructed as complete ring systems.

The generators are of the Oerlikon revolving-field type, 6,000 volts, fifty cycles, making 300 revolutions per minute, and are capable of generating 1,850 kilovolt-amperes on three-phase and 1,380 kilovolt-amperes on single-phase. The generator frame is made in four parts, the segments being fastened together by cast-steel rings. The coils are placed in mica tubes and fastened in the slots by fibre wedges. The poles, of which there are twenty, consist of four laminations each, and are securely fastened to four steel rings which are shrunk on to the spider. The four laminations of the poles are so arranged that the edge of one overlaps the other. The magnet coils consist of copper strips bent on edge.

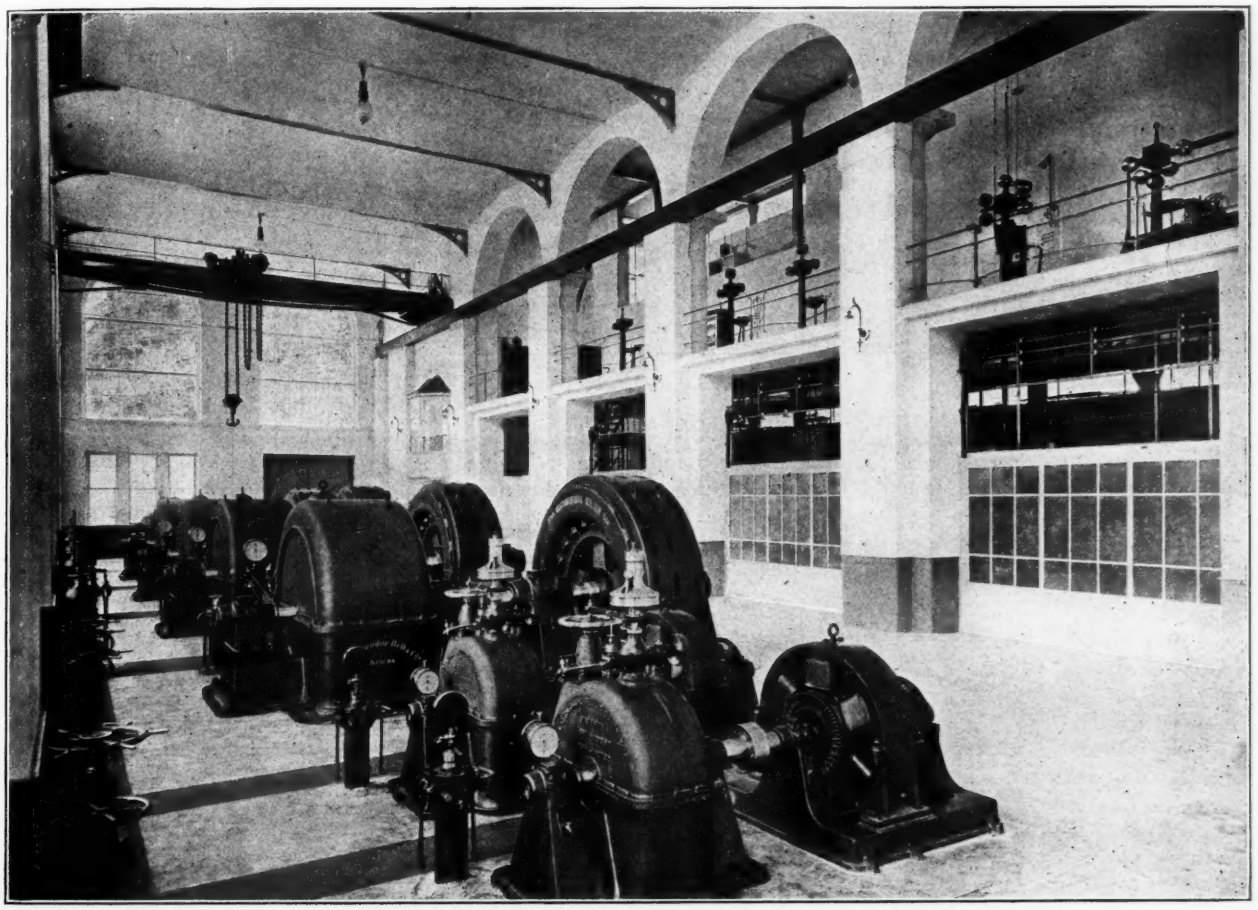
As a 600-horse-power, three-phase reserve generator for the Stausstad-Engelberg Railway works in parallel with the railway power-house, a frequency of thirty-two and one-half was chosen, the generator being coupled directly to the turbine shaft by means of a flexible coupling and making 480 revolutions per minute, giving a voltage of 780 and 540 kilovolt-amperes.

The exciters have a capacity of 100 kilowatts and have a normal voltage of 100, while the maximum voltage is 150. They are six-pole, shunt-wound machines.

The storage battery consists of fifty-six elements, with a capacity of 1,000 ampere-hours or 1,500 amperes for a quarter of an hour, and are arranged in three rows, provided with a double cell switch so they may be operated at a distance. A small direct-current motor is used for operating the switch when charging and discharging the battery.

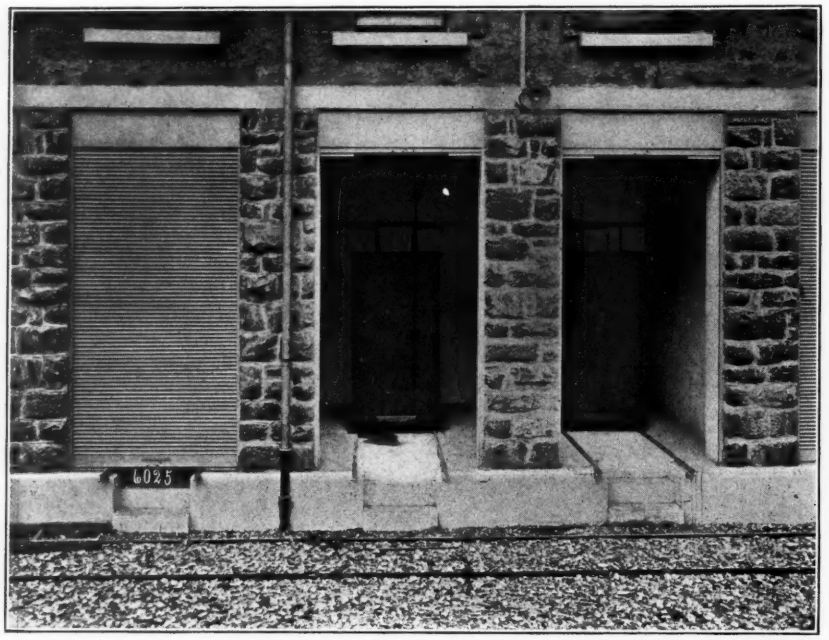
The main transformer station is an annex to the power plant, special attention being paid to its design, not only as regards its architectural features but also considering its lighting and ventilation. The transformers are single-phase, water-cooled oil transformers, each being placed in a separate fireproof compartment, the intervening wall being of heavy masonry; a rolling door protects the entrance to each compartment. The transformers are placed on slide-rails to facilitate ease of handling in case of accident, and a small track runs directly in front of the entrance to the several compartments.

The aisle between the switching and transformer compartments contains on the wall nearest the transformer compartment the pipes of the water-cooling system. This water supply is provided with an automatic alarm system, so that, should there not be an adequate water supply for normal conditions, it is at once known. There are sixteen transformer compartments, ten of which hold transformers,



LUCERNE HYDROELECTRIC PLANT. INTERIOR OF GENERATING ROOM. SWITCH GALLERY AT RIGHT. EXCITERS IN FOREGROUND.

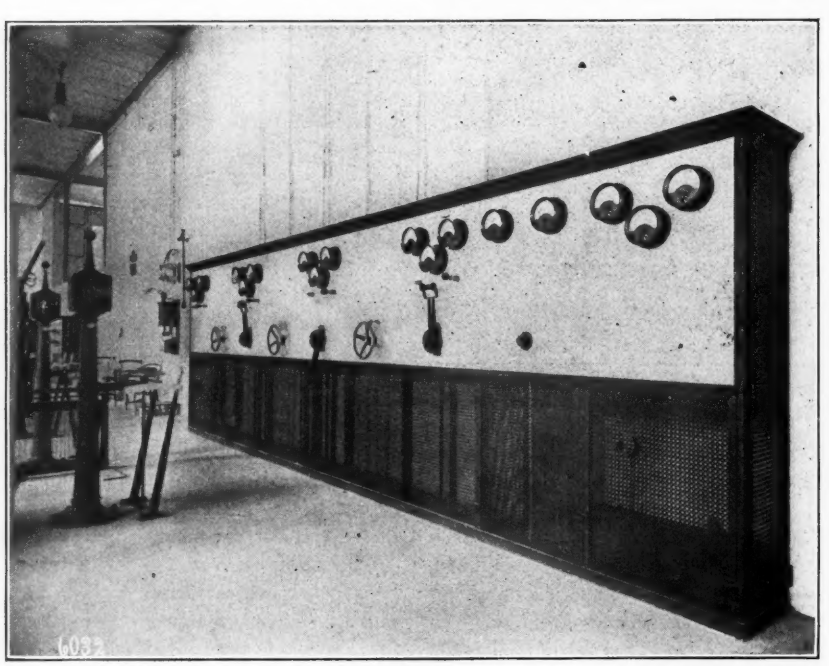
each having a capacity of 700 kilovolt-amperes, having a 6,000-volt primary with a secondary voltage of 27,000, at a frequency of fifty cycles.



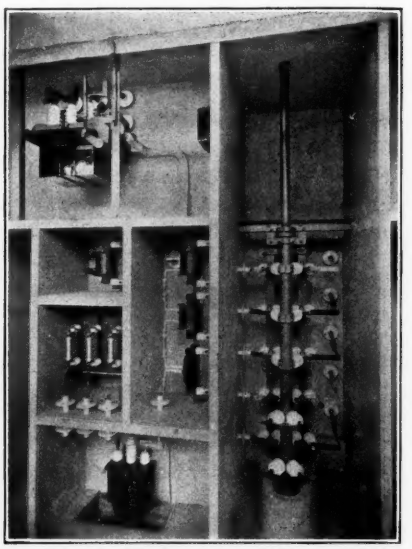
LUCERNE HYDROELECTRIC PLANT. TRANSFORMER COMPARTMENTS.

The care shown in the design of the transformer room was even exceeded in the design of the switching room, a feature which in nearly all power-houses is of secondary importance, but which in this instance occupies nearly as much space as the generating room, care being taken that low and high-tension wires are kept far apart. The entire switching arrangement is constructed on the isolated system, each accessory being placed in a separate fireproof compartment of reenforced concrete.

The switching house has three floors, the first containing the switching apparatus of the generators and exciters, the 6,000-volt bus-bar system and the primary switches for the transformers; the second floor contains the secondary switches of the transformers, the 27,000-volt bus-bar system, and is the main operating gallery from which the whole generating room is overseen; the third floor being in the tower, the floor being flush with the generating room, contains the switches of all outgoing wires and the lightning arresters. The first and second floors are each divided by two division walls, thus giving three distinct compartments on each floor.

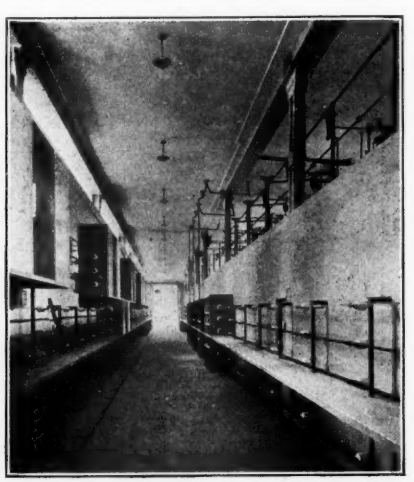


LUCERNE HYDROELECTRIC PLANT. OUTGOING FEEDER PANEL.



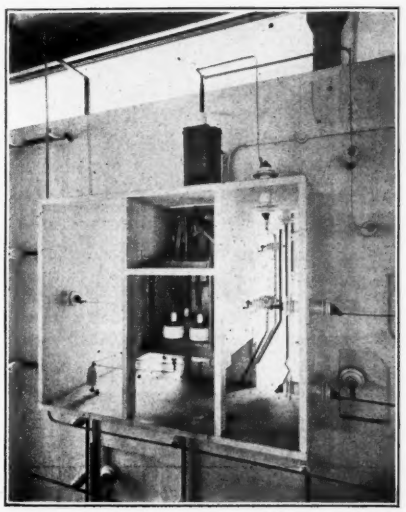
LUCERNE HYDROELECTRIC PLANT. REAR VIEW GENERATOR SWITCH PANEL.

The connections between the generators and switchboards are carried along the ceiling of an arched concrete tunnel beneath the floor line. The first compartment, toward the generating room, of the first floor contains the switching apparatus for the exciter units, generators and the storage battery. The first panel of the board is devoted to the use of the generator for the Engelberg street railway, and carries an automatic oil-switch, a blowout fuse, and the necessary apparatus



LUCERNE HYDROELECTRIC PLANT. 6,000-VOLT BUS-BAR ROOM.

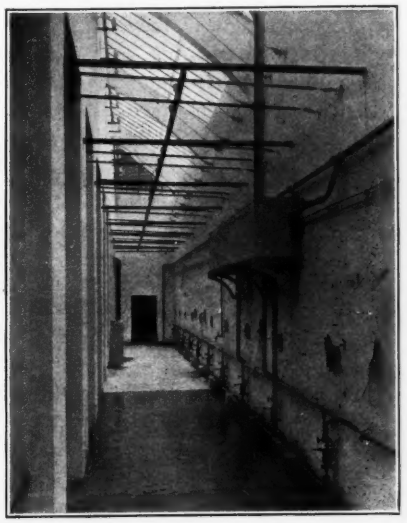
for synchronizing the generator with the Engelberg station. The four adjacent panels are for the 2,000-horse-power generators and their equipment. Each panel contains an automatic oil-switch, or tension transformer and four other transformers, one for the ammeter, one for the wattmeter, and two for the blowout coils of the maximum switch. There is also a double-throw switch by which the generators may be thrown either on the lighting or power bus-bars. Additional compartments are provided for the exciter generators and the battery, as well as for a double-throw switch for charging and discharging the latter. The apartment directly above the one just described is devoted to the switching apparatus of the shunt-wound regulators of the exciters and the exciter rheostats. The centre apartment of the first floor is devoted to the



LUCERNE HYDROELECTRIC PLANT. MAXIMUM OIL-SWITCH FOR 27,000-VOLT CURRENT.

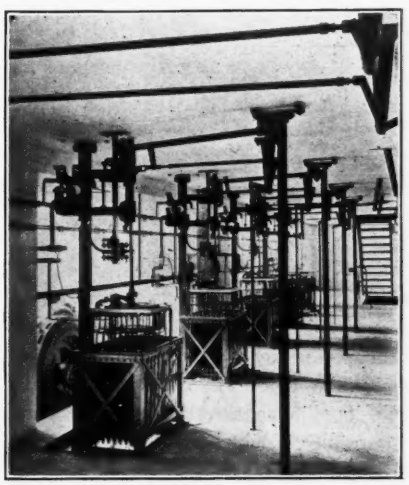
6,000-volt bus-bar system, from where feeders run either to the transformers or to the Engelberg street-railway system, both bus-bar systems being installed for the total capacity of the plant and equipped with sectionalizing and disconnecting switches. Between the feeders of each generator there is a sectionalizing switch, while a disconnect switch is on each side of the generator feeders. The primary switches of the transformer plant are operated from the third apartment of the first floor, directly above them being the secondary transformer switches, so arranged that they may be operated either from the first or second floor, the levers being connected by a small wire. The primary and secondary switches are equipped with time relays and optical and acoustic signal systems. For each transformer there are a signal lamp, time relay and ammeter arranged on a panel by the side of the main switch lever.

In the third floor is located the 27,000-volt, bus-bar systems, provided with the necessary switches, similar to those of the 6,000-volt system. There are altogether



LUCERNE HYDROELECTRIC PLANT. PASSAGE BETWEEN SWITCHROOMS AND TRANSFORMER COMPARTMENTS.

nine outgoing feeder systems, two of which are for lighting the city of Lucerne, three for power for Lucerne and three for light and power for Unterwalden, each of the three three-phase systems being so arranged as to draw current either from the power or lighting bus-bar system.

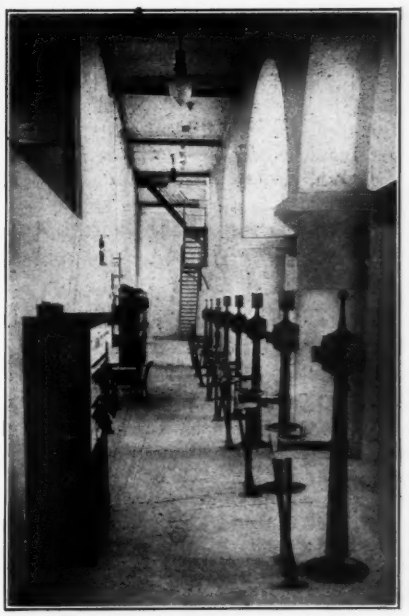


LUCERNE HYDROELECTRIC PLANT. RHEOSTATS FOR EXCITERS.

The lightning arresters are of the Siemens horn type, arranged in series and provided with water rheostats and inductive rheostatic coils. For sudden overloading, due to electrical discharge, each terminal of the lightning arrester is provided with the so-called water-spray apparatus, absorbing the excessive current and conducting it to the earth; the water that is used for this purpose is taken from a spring and is also used for cooling the transformers.

In spite of the exaggerated appearance of the switching system, it has been found to be very simple in operation, everything being operated from the apartment of the second story.

A striking feature of this installation are the columns well known in Swiss practice, being nearly exclusively installed by the Oerlikon Company. Each column supports a wattmeter, an ammeter and a voltmeter, provided with two scales, one for the generator voltage, the other for the phase voltage used in connecting the generators in parallel, while accompany-



LUCERNE HYDROELECTRIC PLANT. CONTROL COLUMNS, SWITCH GALLERY.

ing each column there is a hand-wheel and two levers throwing the generators on the bus-bar systems and operating the carbon switches of the exciters and the rheostats. The interlocking system of the switching arrangement makes it difficult for the operator to make a mistake, as one switch can not be thrown until the one upon which it is dependent has been operated; in addition to this each generator column is equipped with a red and a white incandescent lamp and an electric bell to give signals for throwing in and out the generators. The storage-battery column is equipped with two ammeters and a voltmeter provided with a double-throw switch for measuring the voltage of the bus-bars and the charging and discharging voltage of the battery, the two levers operating an

automatic cutout switch and the switch for the battery.

The exciter column is provided with an ammeter and a voltmeter, the hand-wheel governing the shunt-wound regulator and the two levers being used to control the circuit to the generator for which the exciter is to be used. From this operating gallery the sectionalizing switch in the bus-bars is also controlled, and there is a small switchboard controlling all outgoing wires, the first panel of which contains the instruments of the generator supplying Engelberg. The next three panels are for light and power, and the last two panels bearing the static voltmeters for testing the grounded bus-bars of the 27,000-volt system and the condensers and graphite rheostats. There is still another small switchboard, which is only used for controlling the lighting of the powerhouse, consisting of eight arc lamps and numerous incandescent lamps.

The mechanical equipment of the plant was installed by Th. Bell & Company, of Kriens, Switzerland, while the entire electrical equipment was designed and furnished by the Oerlikon Company, of Baden, Switzerland.

Annual Meeting of the British Association for the Advancement of Science.

The annual meeting of the British Association for the Advancement of Science began in York, England, on August 1, under the presidency of Edwin Ray Lancaster. In his inaugural address the president outlined the advancement of science during the last quarter of a century, which, he said, "will stand out forever as that in which new chemical elements possessing astounding properties have been made known with extraordinary rapidity and sureness of demonstration." Mr. Lancaster devoted much of his address to a review of the increased knowledge concerning radium and gave Ernest Rutherford, of McGill University, Montreal, much of the credit for investigation in this direction.

While speaking of astronomy, Mr. Lancaster made reference to the method of Professor Pickering, of Harvard University, of charting the sky rapidly, and his records of the sky as a whole. "This wonderful new method," continued the president, "is a mode of keeping a record of present movements and changes which promises much for the future of astronomy."

The president made acknowledgment of the assistance rendered by wealthy Americans to scientific research in providing great telescopes and equipment, as well as other helpful gifts for other branches of science. "In the United States this is not infrequent," said the speaker, "while in this country it is rare."

It was announced that Sir David Gill had been nominated for the presidency of the association for 1907.

HARMONIC PARTY-LINE SYSTEMS.[1]

BY WILLIAM W. DEAN.

The name Harmonic Party-Line System has been given to a system of selective bells for telephone party lines which has come into very general use in the last four years among the independent telephone companies of this country. Referring to Kempster B. Miller's book, "American Telephone Practice," you find the following passage which I consider the most lucid explanation of the principle involved in this class of systems which I have ever seen. He says:

"These systems, with one exception, make use of the fact that every pendulum or every vibrating reed has a natural period of vibration, and that it can be made to take up this vibration by the action of a succession of impulses of force occurring in the same frequency as that in which the reed or pendulum vibrates. A familiar example of this is found in one person pushing another in a swing. The swing has its natural period of vibration depending on the length of the ropes, and a gentle push applied at proper intervals by the person on the ground will cause the swing to vibrate with considerable amplitude. If the pushes are applied at intervals not corresponding to the natural period of vibration of the swing, many of them tend to retard rather than help its vibrations, so that a useless bumping results, producing but little motion."

The first harmonic selective party-line system was that invented by J. B. Currier and patented by him in 1881, and used for several years by the New England Bell Telephone Company. In this system the electromagnets with their armatures, which in this case contained the bell tapper, were arranged in series in the line the same as in the Edison harmonic telegraph. Currier produced his pulsating currents by means of pendulums of different lengths, which pendulums were provided with contacts for interrupting the ringing current.

The next improvement invented in this line was the system of J. A. Lighthipe's, patented in 1895, which was used to a limited extent by the Bell Telephone Company on the Pacific coast. Lighthipe's system is almost identical with the harmonic selective party-line systems in use to-day. He was the first one to introduce the condenser in series with the bell across the line to prevent the central office current from flowing through the magnet coils.

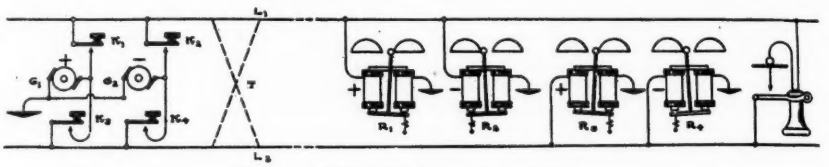


FIG. 1.—GROUNDED HARMONIC SYSTEM.

It is very easy to see and understand why early harmonic systems were not an entire success. Two things are necessary for the successful operation of systems of this class: the current impressed on the ringing mechanism must be of constant frequency and of approximately uniform potential. When we look back on early telephonic conditions, we see that these things were not available. How could we expect to deliver a current of constant frequency and potentials to our bells when we had bad lines, no storage batteries, no ringing machines, and if we had had this apparatus we could not have had the splendid sources of electric power at present available to operate them with. What has really made possible the use of harmonic party-line systems has been the introduction in the last few years of modern engineering methods into the telephone business.

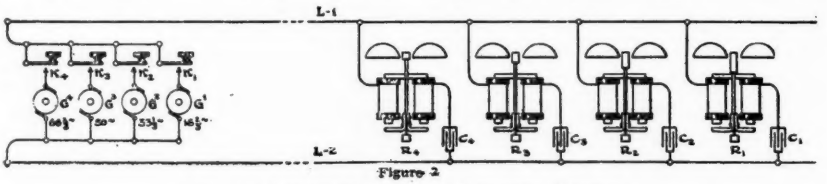


FIG. 2.—METALLIC CIRCUIT HARMONIC SYSTEM.

Early telephone experts never expected that the time would come when each telephone subscriber would be provided with an individual metallic circuit, consequently a large amount of work was done by them along the lines of developing selective party-line systems. I myself remember that in St. Louis, in the early

[1] Abstract of a paper read before the Pittsburg section of the American Institute of Electrical Engineers, March 13, 1906.

eighties, a system which employed the "step-by-step" mechanism was used, and as high as sixteen parties were rung selectively on one line; this was known as the "Bliss" system.

If a committee of telephone engineers were asked to decide the question as to what things were most desirable in a party-line system, their report would be as follows: No earth connections, no relays, no adjustable springs or weights, no step-by-step mechanisms, and that the ringing of the bells should not be appreciably affected by the capacity or resistance of the line. The only way that such a specification could be satisfied would be to have bells whose operation depends upon mechanical tuning.

In order to bring out clearly the advantages of a system using clean metallic circuits as compared with those using earth connections, it will be necessary to describe briefly the latter.

Referring to Fig. 1, we have represented a subscriber's telephone line consisting of wires L-1 and L-2. Connected to earth from the L-1 line are the bells R-1 and R-2; connected to earth from the L-2 line are the bells R-3 and R-4; bells R-1 and R-3 are responsive to pulsating currents of positive sign, and bells R-2 and R-4 to pulsating currents of negative sign. Generator G-1 furnishes pulsating current of positive sign and generator G-2 pulsating current of negative sign. The switches K-1, K-2, K-3 and K-4 are provided at the central office for connecting current of the proper kind to line.

When we consider a system such as that illustrated in Fig. 1, we find that the following objections are present: on account of the presence of earth connections at the substations, the lines are susceptible to bad inductive disturbances, due to electric railway, alternating power and lighting circuits and telegraph. It is apparent that, in order that subscribers be rung selectively, each bell be connected to the proper side of line. In other words, the operator, when she wishes to ring stations 1 and 2, projects either positive or negative pulsating current on to the L-1 half of the metallic circuit, and when she wishes to call station 3 or 4 she connects plus or minus current to the L-2 side of the line.

Now, if a line be transposed, say, at T, to prevent inductive troubles, or if the wire chief at the central office happens to get a jumper reversed in the process of making a cross-connection on the distributing frames, the currents sent out would go to the wrong side of the line, and a wrong subscriber be called, thus causing endless trouble. This class of faults is constantly occurring to my knowledge.

In installing telephones in a system such as Fig. 1, the installer is always obliged to locate accurately the proper side of the line before connecting it to the telephone, which operation entails expense and chances for mistakes. When an operator in this system rings a subscriber, say, No. 4, with the minus pulsating current, and during the process of ringing the subscriber removes his receiver from the telephone hook, part of the current is carried over to the other half of the line and the bell connected to it which responds to like current (No. 2) will consequently give a false ring.

Now we come to the description of a modern harmonic selective system. Referring to Fig. 2, L-1 and L-2 represent the two sides of a metallic circuit telephone line. R-1, R-2, R-3 and R-4 are mechanically tuned telephone bells, each having connected in series with it a one-microfarad condenser across the line. G-1, G-2, G-3 and G-4 are generators designed to ring them. K-1, K-2, K-3 and K-4 are switches used by the operator for connecting the currents of proper frequency to line. It is evident that no transposition of the line at any point or of the terminals of the instruments can effect the operation of this kind of a system, and inasmuch as each bell responds to an entirely different current, no "cross-rings" can be produced by the removal of the receiver during the process of ringing. It is also evident that when telephones are being installed they can be connected to the line without care or reference to polarity, in the same manner that incandescent lamps are connected to a lighting circuit.

Two of the first problems that present themselves in designing a harmonic party-line system are the selection of currents of proper frequencies and voltages and the method of producing the same. Elisha Gray found during his experiments with harmonic telegraph, that frequencies which were related in a ratio of one, three, five, seven and nine produced the least interference. It is evident that to produce currents whose frequencies are related in the above manner, it would be necessary, if one driving motor were used, to use belted or geared transmission which is not desirable. It was found that currents whose frequencies were related in a ratio of one, two, three and four were sufficiently non-interfering for commercial purposes. Currents or frequencies of 2,000 4,000, 6,000 and 8,000 were finally adopted and were generated by a set which consisted of a motor direct-connected to two, four, six and eight-pole generators, the whole outfit running at a speed of 1,000 revolutions per minute. It was found by experiment that high-frequency bells required more power to operate them than the low-frequency ones, and consequently it was found necessary to step up the voltages of the generators as the frequency increased. The voltages which were finally found to be the best were for sixteen and two-thirds cycles, sixty volts; for thirty-three and one-third cycles, 100 volts; for fifty cycles, 135 volts; and for sixty-six and two-thirds cycles, 180 volts. These harmonic ringing sets are provided with a governor, by means of which the speed of the motor is kept constant regardless of the variations of voltage in the power circuit.

We now come to the design of the harmonic bell itself. The following points are essential to a successful harmonic ringer: its armature must be in perfect tune with the current designed to operate it; it must remain in tune, after once leaving the factory, indefinitely; it must be interchangeable with the ordinary single-party telephone ringer, for the reason that a great many of the operating companies find it necessary to change over their old to the new system; it is desirable that the general appearance of the ringer after being installed be the same as that of the ordinary single-party ringer, it being sometimes desirable that the telephone users be in ignorance of whether other subscribers are using party or single-line service.

It is a well-known fact that a device in tune with the energizing force is many times more efficient than one which is not. In working with these absolutely tuned bells I have found that they can be constructed to give any desired degree of sensitiveness.

While the motor-generator ringing machines previously described serve their purpose, they necessarily limit the use of the harmonic system of ringing to such exchanges as can obtain the necessary electric current for their operation. These machines are furthermore expensive in first cost, also in operation and maintenance, when compared to the cost of a telephone switchboard and the cost of current required to operate it. Thus many small exchanges have been prevented from installing the harmonic system, and a big

demand created for a simple and inexpensive method of producing the harmonic currents without the necessity of special power circuits and without a big current consumption. The harmonic converter is a result of this demand. It is made up of four separate units, each consisting of a pole-changing vibrator, a transformer adapted to the frequency of its associated vibrator and designed to give the proper voltage in its secondary winding for the operation of the harmonic ringers previously described, and a condenser also suitably proportioned to the electrical conditions of the circuits. These units are shown with their connecting wiring in Fig. 3. It will be seen that the vibrators V-1, V-2, V-3 and V-4 have electromagnets T operating armatures P similar to the action of an ordinary electric house bell. Upon these armatures are mounted two springs, m and n, which are connected to the terminals of a source of direct-current supply. Four contacts are arranged, two on either side of the springs, so that when the armature is drawn up the current will be allowed to flow through the primary winding T P of the transformer, and when the armature swings back these latter contacts are cleared and the other two contacts are made, causing current to flow in opposite direction through the same primary winding. The condenser C, which is placed across the primary winding of the transformer, takes up the discharges from the coil and prevents sparking at the vibrator contacts. It also assists in rendering the alternating effect in the primary winding more uniform and efficient. One of the secondary terminals on each of the transformers is connected to a common conductor, and together with conductors from the other four free terminals, serve to carry the four frequency-ringing currents to the switchboard.

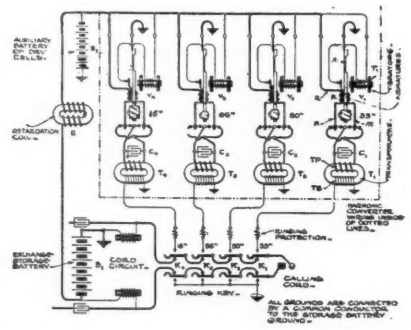


FIG. 3.—CONNECTION OF HARMONIC VIBRATOR.

Unlike the direct-connected motor-driven multifrequency generator, the separate units of the harmonic converter allow the use of the most desirable frequencies for non-interference in ringing. An incidental advantage in the use of separate units for each frequency is that each vibrator will continue to operate perfectly, even though one or more of the other converters or associated apparatus are disabled.

The vibrator or pole-changing mechanism of the harmonic converter is made with massive parts rigidly put together, so that the continual vibration of the armature will not work them loose. The armature itself is made from one piece of tempered steel cut away at its upper part so as to form a thin spring portion as shown at X in Fig. 3. This construction obviates the use of rivets, and gives a solid portion of the metal at its top which can be rigidly held in the vibrator frame. The reduced portion of the armature is made rather long, so as to give a free and easy armature movement and an indefinite life to the spring. At the lower end of the armature is attached an adjusting weight which is used to get the final tuning of the mechanism to the proper frequency. These weights can be raised and lowered during the process of tuning, and securely clamped in place at the proper position. The main difference in the rate of vibration of the armature is obtained, however, by making its reduced or spring portion of different thicknesses, the highest frequency having the thicker spring. Vibrators constructed on these lines do not vary perceptibly from a uniform rate of vibration, even with great changes in the voltage of the operating circuit. The only noticeable effect is the variation in the amplitude of movement, but this has not been found a serious obstacle when operating within the limits of the voltages usually met with in practice, a change of thirty to forty per cent in the case of storage batteries. A governing mechanism is therefore unnecessary, as the proper frequency is always maintained.

The transformers used in the harmonic converter are built after the pattern of those used in electric lighting, with a very efficiently closed magnet circuit. The amount of iron as well as the design of the windings are varied to suit the frequency and voltage required at the secondary terminals, the lowest frequency having the greatest amount of iron and the smallest voltage.

The first experiments on the harmonic converter were directed towards reducing the number of contact points in the vibrators, and the most promising scheme developed was the use of a double primary transformer with a vibrator having two contacts, arranged one on either side of the armature, and so connected as to cause current to flow, first in one primary coil of the transformer and then in the other coil but in an opposite direction. Thus an alternating current was produced in the secondary winding. Condensers were placed across each of the primary windings of the transformers to reduce sparking at the contacts and assist in the circuit action. It was found, however, that the use of two primaries greatly reduces the efficiency of the transformers, giving less output and a greater no-load or exciting current than when one primary is used. Also the breaking of the current at one vibrator contact, which necessarily has a comparatively small amount of movement, limits the output of the machine as well as restricts its use to low-voltage primary circuits.

A multiple break and a complete reversal of the current in the vibrator, as shown in the perfected harmonic converter, were thus found necessary to correct these evils. The breaking of the current at the two contact points simultaneously not only reduces the voltage at each break to one-half that of the primary source, but doubles the distance of contact opening in the circuit, thereby allowing the harmonic converter to be operated from the higher voltage primary power circuits.

It has been found in practice that the various frequencies used in the harmonic system of party-line ringing, when produced by properly designed alternating-current generators, give no noise in the talking circuits or inductive disturbances in the lines when ringing. This is probably due to the character of the alternating current, which has a curve approaching that of a true sine wave. The use of a transformer and condenser in a harmonic converter tends to smooth out the current curves produced by the pole-changing vibrators so that the quiet effect of the sine waves is obtained.

Another and more important problem presented itself when operating the harmonic converter from a storage battery of a common battery exchange, as the rapidly recurring changes in potential, due to the action of the vibrators, is sufficiently strong to make the entire talking system noisy. When the exchange battery is of large size and the taps for the harmonic converter are taken directly off its bus-bars, this noise is only slightly perceptible. But any disturbances of

this nature are not to be tolerated in a modern exchange installation, so that efficient means had to be produced to entirely overcome this defect. The use of a retardation coil of sufficient impedance to kill the noise in the talking circuits cuts down the efficiency of the harmonic converter to such an extent that its output is not great enough to ring the bells of the party-line system. However, a device was produced as shown in the diagram, Fig. 3, which allows the use of a very high impedance coil and still retains the full efficiency of the harmonic converter. This retardation coil is placed in the supply or feed wire between the main exchange battery B-1 and the harmonic converter, and between them is bridged or floated an auxiliary battery B-2. Like poles of this battery and the main exchange battery are connected to the same wires, so that the auxiliary battery is kept constantly charged, and in fact, called upon for no discharge except when the electromotive force, due to the main battery, is choked down and prevented from providing a peak current, the deficiency being then momentarily supplied for each wave by the auxiliary battery. In fact, the auxiliary battery may be called an equalizer, since it really takes up and absorbs the noisy back surgings, which would otherwise produce a disturbance in the entire common battery system. This auxiliary source of current supply can be a small storage battery, or even electrolytic cells, but in practice ordinary dry cells have served the purpose.

The power consumption and actual results obtained in practice from harmonic converters with fifty-five-watt transformers will serve as an example of the possibilities of this piece of apparatus. With a twenty-two-volt source of current, it requires less than 0.58 watt to operate the four vibrators, while with the primaries of the transformers connected, this consumption is increased to about six and one-half watts. The latter figure represents the total no-load power required when the harmonic converter is connected for regular exchange service. This machine will furnish power to ring simultaneously over fifty fully loaded lines of four bells each, and while an excessive load, it yet remains in the safe limits of operating. Such a machine will do easily all of the ringing of an exchange of 6,400 lines.

When no direct-current source of power is available, primary batteries can be successfully used for operating the harmonic converter. In the case of small exchanges, dry cells are used to a large extent. In any event, it is desirable to have the primaries of the four transformers normally disconnected from the vibrators so that the no-load current will be at a minimum. This is done by means of a magnetically operated switch or relay, which is in turn operated by contacts on the ringing keys. As previously stated, the total no-load power consumed is then less than 0.58 watt—the energy required for keeping the vibrators in motion. With small exchanges this no-load current can be eliminated by allowing the vibrators to remain at rest excepting when actually required for ringing. In this case, the relay switch just mentioned is made to complete the power circuit to the vibrators and set them in motion each time a ringing key is operated. The armatures of the vibrators are brought into full motion with practically no time-loss and with no effect whatever on any but the ringer which it is desired to actuate.

All of these methods of operating the harmonic converter have been in actual use in a large number of exchanges for a sufficient length of time to conclusively prove the extreme reliability and great economy of this method of producing harmonic ringing currents.

The Report of the Westinghouse Electric and Manufacturing Company.

The report of the board of directors to the stockholders of the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., for the six years ending March 31, 1906, was presented at the meeting held on July 25.

The company's foreign interests are included in the following enterprises:

The British Westinghouse Electric and Manufacturing Company, Limited, London, England.

Société Anonyme Westinghouse, Paris, covering France, Spain, Portugal, Italy, Belgium, Switzerland and Holland and their dependencies.

Westinghouse Electricitäts Actiengesellschaft, Berlin, for Germany.

Westinghouse Electric Company, Limited, London, of which all shares are owned by the company and has all territory not covered by the companies named.

The Société Westinghouse Electrique de Russie has been organized (under French laws) to purchase an electrical works in Russia, and these have been developed by the Society Anonyme Westinghouse, of St. Petersburg (the Russian Brake Company) to undertake extensive work in Russia.

During the period from March 31, 1900, to March 31, 1906, the East Pittsburg works were twice increased in size and capacity; in 1901-2 by extensions yielding 653,711 square feet of additional floor space. The six-story general office building was also erected in 1901, realizing a further large area of floor space in the works as additional manufacturing space.

In 1904-5 these works were again enlarged by the building known as the east machine shop, with floor area of 694,943 square feet; also 45,980 square feet additional area, all commanded with powerful electric cranes, in a building connecting this shop with other works buildings. These additions gave the East Pittsburg works nearly four times the original floor space.

The Cleveland (Walker) works were changed in 1904 into an iron foundry, admirably equipped, and since then used for the more important foundry work.

The rapid growth of the business is now quite fully occupying the facilities of both the Cleveland and Allegheny foundries.

The Newark works were completely rebuilt since 1902, and additions were made providing a total floor space of 185,000 square feet.

All these additions to the works in East Pittsburg, Cleveland and Newark are now fully equipped with machinery and are prepared to care for the large business now being done, as well as for a reasonable growth. Especial attention has been given to provide adequate facilities for taking care of the rapidly growing and important business in turbo-generators, as well as the building of electric locomotives of all sizes and types, both for special and regular railroad service.

Following is the total number of employés, exclusive of the selling organization, at the close of each of the past six fiscal years: 1901, 7,971; 1902, 9,305; 1903, 11,269; 1904, 10,622; 1905, 11,894; 1906, 14,705.

During the past year a line of railway between East Pittsburg and Trafford City was completely equipped by this company with the latest type of catenary suspension trolley line for high-tension alternating-current transmission, and is being used in testing single-phase electric locomotives manufactured. This railway is also fitted with the third-rail and adequate substations for testing locomotives using direct current, thus affording complete facilities for thoroughly testing under service conditions this important and

rapidly increasing part of the product of the works.

To provide for the rapidly increasing business of the Sawyer-Man Electric Company, demanding larger quarters, a plot of ground was recently purchased in Watsessing, N. J., on which entirely fireproof buildings containing 206,700 square feet of floor space are being erected. These buildings will be equipped with the most modern appliances for the manufacture of incandescent lamps. A large addition to the main factory of the Bryant and Perkins companies, in Bridgeport, Ct., is rapidly nearing completion.

The single-phase system developed by B. G. Lamme, chief engineer of the company, has for more than a year been in successful operation on a number of important interurban roads. It has been adopted by the New York, New Haven & Hartford Railroad for the operation of trains on its main line from New York city to Stamford, Ct. This contract is now in process of execution. Two other important railroads have placed contracts, namely: the Grand Trunk Railway, of Canada, for the electrification of the Sarnia tunnel, and the Spokane & Inland Railway, of the state of Washington, for the complete operation of its lines by this system.

GENERAL BALANCE SHEET, MARCH 31, 1906.

ASSETS:		
PROPERTY AND PLANTS:		
Factory plants at East Pittsburg and Allegheny, Pa., and Newark, N. J., including real estate, buildings, machinery and equipment	$10,630,177.14	
Other real estate, including property in Garrison place, Pittsburg, under agreement for sale at $500,000. Book value, $415,795	448,177.73	
		$11,078,354.87
QUICK ASSETS:		
Cash	$6,938,899.88	
Subscriptions to five per cent Convertible Sinking Fund Bonds, due in April, May and June, 1906	2,031,817.00	
Accounts and Bills Receivable	7,414,600.58	
Interest and Dividends Accrued, not due	93,102.46	
Raw Materials and Supplies at purchase prices and Finished Parts and Completed Apparatus and Work in Progress, at factory costs	10,836,994.06	
Completed Apparatus on Consignment at District Sales Offices and other places, for resale, at factory costs	1,046,498.82	
		28,361,912.80
INVESTMENTS:		
Stocks and Bonds of Subsidiary American Companies—Manufacturing Companies of which over ninety-five per cent of the entire Capital Stock issued and all Bonds are owned by this company. Par Value, $7,210,900.00	5,191,146.93	
Stocks and Bonds of Foreign Companies—operating manufacturing plants in Canada, England, France and Russia and selling companies with valuable patent rights in Germany, China, Japan and other foreign countries. Par Value (pounds, francs, marks and roubles) approximately $13,750,678.95	10,661,541.79	
Stocks and Bonds of Lackawanna & Wyoming Valley Rapid Transit Company	6,300,000.00	
Miscellaneous Securities	434,501.36	
		22,587,190.08
OTHER ASSETS:		
Charters, Franchises, Patents, Office Furniture and Fixtures at Factory Plants and District Sales Offices, Insurance and Taxes paid in advance, etc		7,034,537.22
Total Assets		$69,061,994.97
LIABILITIES:		
CAPITAL STOCK:		
Preferred	$3,998,700.00	
Assenting	20,996,350.00	
Non-Assenting	3,650.00	
		$24,998,700.00
FUNDED DEBT:		
Convertible Sinking Fund five per cent Gold Bonds	$15,000,000.00	
Debenture Certificates	2,500,000.00	
		17,500,000.00
COLLATERAL NOTES:		6,000,000.00
CURRENT LIABILITIES:		
Bills Payable to be retired at maturity	$7,157,000.00	
Debenture Certificates—to be retired July 1, 1906	100,000.00	
Accounts Payable	1,482,819.55	
Interest Accrued, not due	282,833.34	
		9,022,652.89
*PROFIT AND LOSS—SURPLUS:		11,540,642.08
Total Liabilities		$69,061,994.97

NOTE—This company has a contingent liability, as guarantor, of $850,000 bonds of the Walker company due 1916 secured by mortgage on the property and plant of the Walker Foundry Company, Cleveland, Ohio.
*Subject to dividend declared March 21, 1906, payable April 10, 1906.

The following data show the sales of the company for the fiscal years 1900-1901 to 1905-1906, both inclusive: April 1, 1900, to March 31, 1901, $12,516,071.86; April 1, 1901, to March 31, 1902, $17,927,339.43; April 1, 1902, to March 31, 1903, $19,571,294.91; April 1, 1903, to March 31, 1904, $18,569,614.21; April 1, 1904, to March 31, 1905, $16,570,717.13; April 1, 1905, to March 31, 1906, $24,939,602.35.

For the first five months of the present calendar year the sales have averaged above $2,850,000 per month, which, if maintained, as from present indications we may reasonably expect, will make a total for the year of above $34,000,000.

The above statement of sales does not include the sales of the subsidiary companies, the Bryant and Perkins companies, the Sawyer-Man Electric Company and the R. D. Nuttall Company, which for the fiscal year 1905-1906 amounted to about $3,500,000. All of these subsidiary companies show large increases for the current fiscal year.

It is of interest to note the growth of the sales department in connection with the foregoing table, as follows: number of employés—April 1, 1900, 124; April 1, 1901, 150; April 1, 1902, 192; April 1, 1903, 243; April 1, 1904, 294; April 1, 1905, 391; April 1, 1906, 429.

The sales of railway motors during the past year have increased fifty-one per cent over any previous year in the company's history. The sales of electropneumatic unit-switch system of multiple control have continued large, showing an increase of upwards of sixty per cent over any previous year.

The central station business, including long-distance transmission plants, has been characterized by the more general use of steam-turbine directly-driven generators. The business in turbine-driven generators has been very large and is constantly on the increase.

The industrial and power department, which directs the sales of apparatus for industrial application, including machine shops, mills, mining motors and generators for resale, has shown an increase during the year 1905-1906 of forty-six per cent over the best previous year, and for the early months of the current fiscal year the sales have been on a basis very largely in excess of last year's increase.

Values of Ties of Different Materials.

In Bulletin No. 75 of the American Railway Engineering and Maintenance of Way Association W. C. Cushing, chief engineer of maintenance of way, Pennsylvania lines west of Pittsburg, southwest system, gives a series of tables showing the cost delivered which a white oak tie, lasting ten years, must reach before it will be economical to use other kinds of tie; how long ties of different materials must last in order to be as economical as white oak costing seventy cents and lasting ten years; and the first cost which can be paid for different kinds of ties in order to be as economical as white oak costing seventy cents and lasting ten years. Mr. Cushing states that some of the data used are costs established from actual practice and from reliable information given, while in other cases assumptions have been made from the best information available, and from these apparently trustworthy premises the following deductions have been made.

With white oak ties costing seventy cents delivered on the railroads, it is economical at the present time to buy inferior woods at a price not to exceed fifty cents, have them treated with zinc-chloride or zinc-tannin, lay them in the tracks without the use of tie-plates (except where it is necessary to use them on oak ties), and use a standard railroad spike. A life of ten or eleven years has been found to be a maximum for such ties without the use of tie-plates and better fastenings, and if the life of ten years is not attained, there will be that much loss to the company.

When a white oak tie reaches a cost of eighty-six cents or eighty-seven cents delivered on the railroad, it will be economical to use the zinc-creosote process, or straight creosote costing thirty cents, if the tie costs forty-six cents delivered on the railroad and will last sixteen years; or, it will be economical to use straight creosoting, costing eighty-five cents for treatment, if the tie can be made to last thirty years, which is French practice, before the oak tie reaches a cost of eighty cents delivered on the railroad. In both of these cases it is assumed that tie-plates, wood screws and helical linings are used because ties can not be made to last more than ten or twelve years without the use of proper fastenings; since, otherwise, the tie will be destroyed by mechanical wear. It is necessary, therefore, to use improved fastenings when we expect to obtain a life of ties greater than ten or eleven years.

It will also be economical to use a steel tie costing $1.75 delivered, if it will last twenty years.

When the white oak tie reaches a cost of ninety cents delivered on the railroad, it will be economical to use either ties of inferior woods treated with zinc-tannin if a life of fourteen years can be obtained, the improved fastenings being used; or a concrete tie costing $1.50 if it will last twenty years.

When the price of white oak ties reaches $1 it will be economical to use a steel tie costing $2.50 if it will last thirty years, a concrete tie costing $2.25 if it will last thirty years, or an inferior wood tie treated with zinc-chloride if a life of twelve years can be obtained.

With ties of inferior woods costing forty-six cents delivered on the railroad we must obtain a life of from eighteen to twenty years, whether treated with zinc-chloride, zinc-tannin or zinc-creosote, to make them as economical as white oak ties costing seventy cents. It is assumed, of course, that they must have the most approved fastenings in order to attain an age as great as that.

With inferior woods costing forty-six cents delivered on the railroad, and if the creosoting costs thirty cents, it will be necessary for us to obtain a life of twenty-one years in order to make them as economical as white oak ties costing seventy cents delivered.

With inferior wood ties costing forty-six cents delivered, and with the creosote treatment costing eighty-five cents as in French practice, it will be necessary for us to obtain a life of thirty-six years from the ties in order to make them as economical as white oak ties costing seventy cents delivered.

With steel ties costing $1.75 each delivered, it will be necessary for us to obtain a life of twenty-eight and one-half years in order to have them as economical as white oak ties costing seventy cents delivered. This price is a little less than the cost of the Buhrer steel ties in the tracks at Emsworth.

With concrete ties costing $1.50 each delivered, it will be necessary for them to last twenty-eight years before they will be as economical as the white oak ties costing seventy cents delivered.

With steel ties costing $2.50 delivered and concrete ties costing $2.25 delivered, which are approximately the prices of the Seitz steel tie and the Buhrer concrete tie, in the tracks at Emsworth, it is necessary for them to last over fifty years each in order to make them as economical as the white oak ties costing seventy cents delivered.

In order to make treated inferior woods as economical as white oak costing seventy cents delivered, when the treated ties are equipped with proper fastenings in order to make them last as long as has been found practicable by experience, we can only afford to pay for the ties delivered on the railroad, ten cents each when treated with zinc-chloride; twenty cents each when treated with zinc-tannin, or creosoted at thirty cents; twenty-three cents each when treated with zinc-creosote, and twenty-nine cents each when creosoted in accordance with French practice.

In order to make them as economical as white oak ties costing seventy cents delivered, we can only afford to pay $1.48 each for steel ties which last twenty years, and $1.79 each when lasting thirty years.

In order to make them as economical as white oak ties costing seventy cents delivered, we can only afford to pay as first cost of concrete ties delivered, $1.15 each if they last twenty years, and $1.57 each if they last thirty years.

We know nothing about the life of concrete ties, and it is at least very desirable to experiment with them for yard and side tracks, even though we do not use them in the main tracks, because they might lie undisturbed in yard tracks for many more years than they would in main tracks.

When white oak ties are costing seventy cents delivered (about present prices), we can afford to buy inferior oak and other hard woods at forty-five cents to fifty cents (present prices), and have them treated with the zinc-tannin or zinc-chloride processes, and only use common spike fastenings.—*Railway Age.*

Wireless Apparatus to Prevent Collisions at Sea.

Consul J. I. Brittain, of Kehl, reports that a Berlin engineer has applied for a patent for an invention to avoid collisions between vessels at sea. By the inventor's system vessels are supplied with special wireless telegraphic apparatus which acts over a short circuit, even as short a distance as half a mile. As soon as a vessel enters within a certain distance of another vessel, this telegraphic apparatus acts automatically in such a manner as to close the steam tube to the screw on each vessel. The machinery is thus instantly checked, and the steamers have time to reverse the engines or reduce speed. In this manner accidents can be prevented. The apparatus is for use in fogs and other heavy weather.

The Electric Car Equipment of the Long Island Railroad.

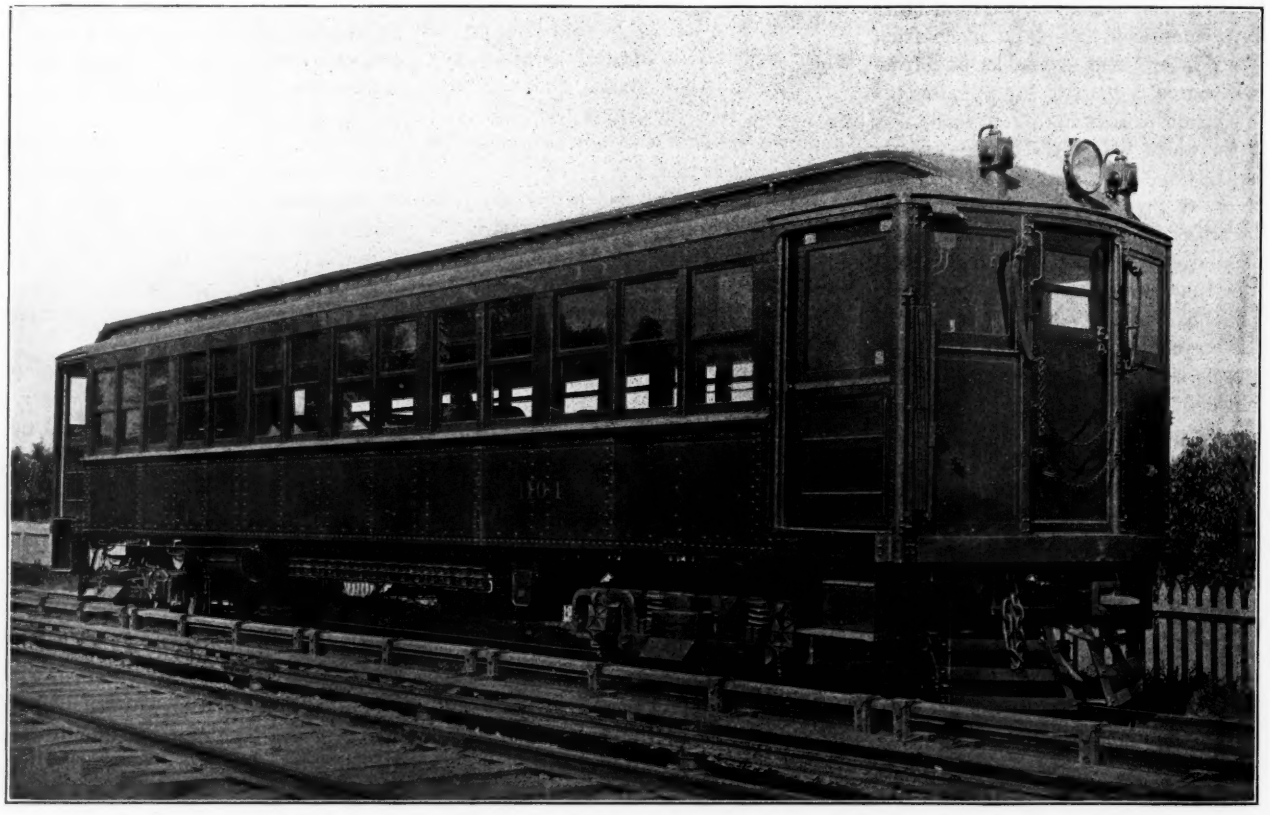
By W. N. Smith.

The design of the car equipment of the Long Island Railroad is based upon a careful study of the traffic conditions as they were outlined by the railroad officials at the commencement of the undertaking, calling for trains with the number of cars varying from two to six per train at different hours of the day, in regular operation, while heavy excursion travel to the beaches and race-tracks would occasionally require trains of ten or twelve cars. Some of the service is express and some local. It was deemed of the greatest importance to provide a single type of equipment that should be uniformly available for all the varying conditions of train service.

The proposed local service on the Atlantic avenue division involved making stops at an average of about 1.6 miles. The express service originally contemplated between Flatbush avenue station and Jamaica provided for only one intermediate stop in the 9.63 miles between them. On the Rockaway Beach division, a local train making all stops between Flatbush avenue and Rockaway Park would average one stop every 0.99 mile, while an express run to Rockaway Park involved a run seven miles in length at the highest practicable speed.

These runs called for a schedule speed including stops of about twenty-five miles per hour for local trains on the Atlantic avenue division, and about thirty and one-half miles per hour for the express trains. Upon the Rockaway Beach division, with relatively more frequent stops, the local run called for a schedule speed of about twenty miles per hour, while the express run, with seven stops in the 15.88 miles, called for about twenty-five miles per hour. The average length of stop was usually assumed at thirty seconds.

The fact that the Atlantic avenue division is partly in a subway, and the need for interchangeability with the rolling stock of the Interborough Rapid Transit subway, has much to do with the design of the cars. The complete success of the first all-steel passenger cars ever built, and which were designed by George Gibbs for the New York subway, led him, in his capacity as chief engineer of the Long Island Railroad electric conversion, to advocate their use on this road as well. To the Interborough Rapid Transit Company and the Long Island Railroad Company belong, therefore, the distinction of being the first railroads in the world to adopt this radical departure in car construction, thus insuring to the public complete immunity from the danger of fire in cars equipped with apparatus carrying powerful electric currents. The incidental advantages of these steel over wooden cars in superior strength and durability are, of course, likewise of importance in insuring their adoption. As the Long Island Railroad cars were obliged to meet very similar conditions, both as to the physical nature of the route to be traversed and the class of travel to be handled, they were built along practically the same lines as the above-mentioned steel cars for the New York subway. In fact, except for the steps, which are made necessary by the low platforms at stations in the suburban districts, the steel car bodies are practically identical with those designed for the New York subway.



Steel Motor-Car, Long Island Railroad.

The principal dimensions of the steel car bodies are as follows:

Length over body corner posts	41 ft. ½ in.

Length over buffers.....	51	ft.	2	in.
Length over draw-bars.....	51	"	4	"
Width over side sills.....	8	"	6¾	"
Width over sheathing.....	8	"	7	"
Width over eaves.....	8	"	8	"
Width over window sills....	9	"	½	"
Width over platform floor...	8	"	10	"
Height from under side of sill to top of plate.....	7	"	1	"
Height from under side of centre sill to top of roof..	8	"	9¼	"
Height from top of rail to under side of sill at truck centre (car light).....	3	"	3⅝	"
Height from top of rail to top of roof with car light.	12	"	¾	"

The principal dimensions of the steel trailer-cars are the same as those for motor-cars, and they may, if desired, be readily converted into motor-cars.

Car Body Framing—While the conformation of the car body is practically identical with the conventional type of steam railroad coach, the adoption of steel as the constructive material is responsible for some differences in the general designs of car framing that have been hitherto followed in wooden-car construction.

The principal members of the car framing are of the following rolled-steel shapes:

Side sills, 5 by 3 by ½-inch angles.
Centre sills, 6-inch I-beams, 17.25 pounds per foot.
Body end sills, 3 by 2 and 4 by 2-inch angles.
Body end posts, 2½ by 2 by ¼ and 2 by 1⅜ by ¼-inch angles.
Compound side posts, 3 by 2 by ¼-inch tees.
Single side posts, 3 by 3 by ¼-inch tees.
Side plates, 4½ by 3 by 5-16-inch angles.
Body end plates, 3 by 2 by ¼ and 3 by 3 by ¼-inch angles.
Platform sills, 4 by 3 by ⅝-inch angles.
Platform end sills, 6 by 3½ by ½-inch angles.
Belt rail, 4½ by 2¾-inch bulb angles.
Carlines, 1¾ by 1¼ by 3-16-inch angles.
Purlines, 1½ by 1½ by ⅛-inch angles.
Hood curve angles, 1¾ by 1¼-inch angles on top and 3 by 2 and 2 by 2-inch angles on end.
Vestibule end bow, 3 by 3 by 5-16-inch angles.
Cross truss, horizontal ties, 4 by 3 by ⅜-inch angles.
Cross truss, diagonal brace, 4½ by 3 by 5-16-inch angles.
Bridging, ⅜ by 4½-inch plates.

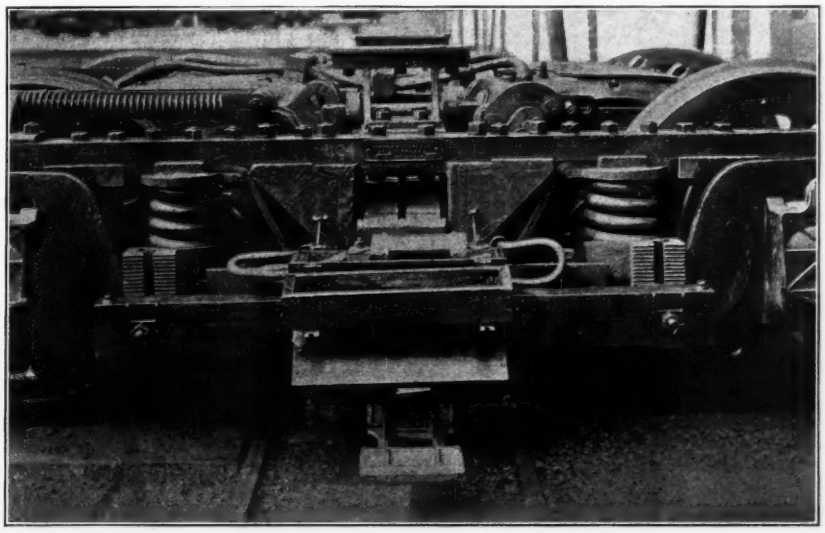
The draft gear comprises a spring draw-bar of the Van Dorn automatic type, supported on a sector bar under the car platform, the radius bar being centred upon a pin set in a cast-steel auxiliary bolster bolted to the centre sills about two feet seven inches in advance of the body bolster. Reaching back from this pin to the body bolster, where it is fastened in a similar way, is a continuation of the radius bar, the above-mentioned pin construction being designed to form a sort of knuckle in the radius bar, which can not be made long enough to reach all the way back to the body bolster because of the ninety-foot radius curve around which the cars are designed to run. At either side of the draw-bar, safety coupling chains have been provided, fitted with springs and anchor forgings fastened to the anti-telescoping plate under the platform end sill. To carry the weight of the radius bar, its outer end is carried in a sector guide directly over the draw-bar proper, just back of the draw-head.

The buffer beams are of oak, faced with one-half-inch-by-six-inch steel plates.

The vestibules are of the Gibbs patent type with floors of steel plates. The vestibule side doors are arranged to slide in pockets in the sides of the car, leaving the entire platform to the passengers. These doors close against pneumatic cushions so as to readily release the clothing of passengers if caught by the closing of the door. The device for operating the side doors consists of a series of bell cranks and levers so arranged that the movable parts are either overhead in the vestibule or entirely outside of it, leaving the entire interior of the vestibule clear. The side doors are operated by brakemen standing outside of the doors at the extreme end of the vestibule. Side steps are provided with plain wooden treads, the gangway being fitted with trap doors of three-sixteenths-inch sheet steel, to enable the use of the entire width of the vestibule when the side doors are closed. The vestibule floor and drop doors are covered with the Mason patent floor covering. The vestibule end door, when in the extreme open position, is folded over the master controller, the brake valve and all other apparatus in the motorman's compartment. The upper half of this door is glazed, like the others. When this door is shut, and the side doors closed, the entire vestibule is available as a motorman's compartment, and the above-mentioned control apparatus is then entirely exposed.

The body end doors are of the double sliding type and are fitted with a door-coupling device that will hold them in any desired position to prevent them from closing when trains are rounding curves. The marker lamps, which are mounted on the hood over the vestibule platforms, are operated from inside of the vestibule by handles extending through the canopy sheathing. The handles are fitted at the lower end with discs carrying colored crystals that correspond to the color of the lenses on the four sides of the marker lamps.

In the vestibule at the motor end of the car, just forward of the end door pocket on the left-hand side facing outward, is placed a swinging door, made convex, of pressed steel, so as to form a pocket to contain the auxiliary control switchboard panel.



STEEL MOTOR-CAR EQUIPMENT OF THE LONG ISLAND RAILROAD—THIRD-RAIL SHOE, FUSE AND CONNECTIONS.

All motor-cars are equipped with pilots suspended from the platform buffers, and the vestibules are fitted with pantagraph safety gates and guard chains to prevent trainmen and passengers from falling between the cars. The usual grab-handles are also fitted to the sides and ends of the vestibules. An air whistle is also provided over each vestibule, with its operating valve situated conveniently to the control apparatus. Wooden paddles are carried in the vestibules of all cars, which are used to raise the contact shoes from the conductor rail when necessary.

The side sheathing of the car consists of steel plates one-eighth inch thick, their lower edges being flush with the bottom

of the sill. The bulb angles which form the belt-rail and the window sills overlap this sheathing. The post covers between the windows are of special pressed steel, flanged out at their lower ends to fit over the belt-rail which runs along the entire length of the car body outside of the posts. The top ends of the post covers extend under the letterboard, which is a steel plate seven and one-sixteenth inches wide, running the entire length of the car, riveted to side plates. The letterboard in turn is overlapped by the eaves moulding as described above. In this manner the entire outside covering of the car is waterproofed by simply overlapping its component parts, avoiding all cracks into which the water can run by gravity. All joints between the side sheathing plates are covered with sheet-metal battens, laid on with thick red lead and secured by rivets.

The flooring of the car body is of corrugated sheet iron, and is supported by the longitudinal sills and the steel-plate bridging that is riveted across the space between the sills. The corrugated sheets are provided with metal clips which are riveted to the sheets at about ten-inch centres, to secure the "Monolith" plastic floor upon which, after being finished, the maple floor strips are laid with brass screws. This monolithic floor is absolutely fireproof and is laid on in the form of a cement, which, when set, has a smooth hard finish.

The interior of the car is finished as follows: the window panels, end panels, and mouldings inside of the car are of sheet steel painted a dark green color and relieved by gold stripes. The headlinings are composite board, painted light green, decorated in gold. The hardware fittings are of lacquered bronze. The arrangement of the seats is similar to that used in subway and elevated railway cars generally. The seat frames are of steel construction carried upon brackets riveted to the side posts. The cushions and seat backs are of rattan. The seating capacity of each car is fifty-two persons. Strap rails of polished mahogany are also provided running along each side of the car in the clerestory, supported in bronze brackets.

The wainscoting is of steel, backed by asbestos "Ceilinite," so as to make it conduct heat less readily.

The side windows are arranged to raise from the bottom and glass in all doors and windows is polished plate. The deck sash are arranged to secure ample ventilation without drafts, all being operated simultaneously by operating levers at both ends of the car. The sash are fitted with double thick chipped sheet glass.

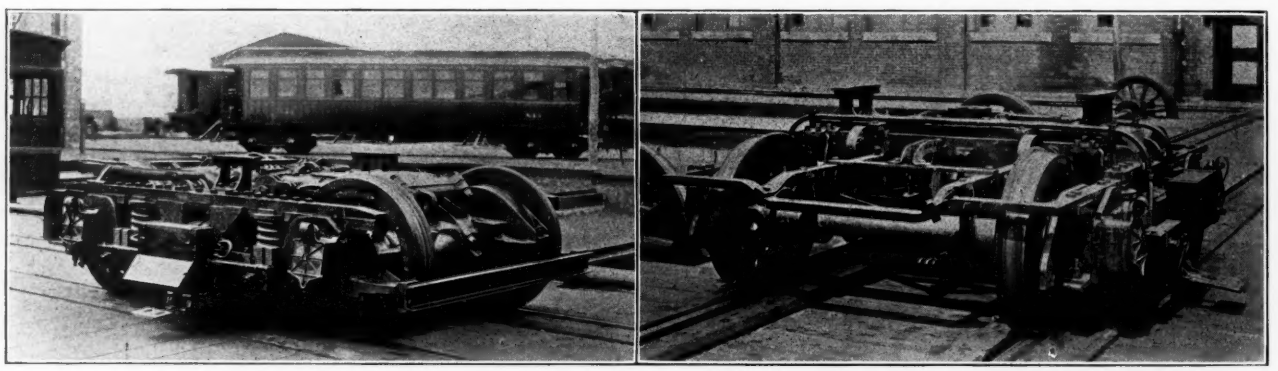
The side windows and the body end doors are provided with Pantasote curtains. The window sash are fitted with counterbalancing steel springs and sash locks and lifts of an improved type. All window capping and other mouldings inside of the car are of aluminum shapes secured by nickel-plated brass screws. The front windows of the vestibules are stationary. Ventilation in the vestibules is secured through the movable sash in swinging doors, or through side vestibule doors, which are equipped with combination door holder and motorman's arm rest.

There are 130 steel motor-cars and four steel trailers, all of which were built at the Berwick, Pa., shops of the American Car and Foundry Company. They were personally designed by George Gibbs, chief engineer of electric traction of the Long Island Railroad, and a number of United States and foreign patents have been issued to him covering the various features of the construction.

The motor and trailer trucks are of the Master Car Builders' type, the wheel base of the motor trucks being six feet eight inches for thirty-six-inch wheels, the trailer trucks being five feet six inches wheel base for thirty-inch wheels. The distance between truck centres is thirty-four feet. The general dimensions of the motor truck are:

Gauge of track	4 ft. 8½ in.
Distance between backs of wheel flanges	4 " 5⅝ "
Height of truck centre-plate above rail, car body loaded with 15,000 pounds	31½ "
Height of truck side bearings above rail, car body loaded with 15,000 pounds	35½ "
Wheel base	6 " 8 "
Weight of truck complete with two gears, but without motors	13,800 lbs.
Weight on centre-plate with car body loaded	30,885 "
Weight of one motor on truck transom	3,500 "
Torque of one motor on truck transom	3,000 "

The trailer trucks are of generally similar type, but of five feet six inches wheel base, and somewhat lighter construction. The bolsters are of white oak, in three pieces, with iron plates placed between the timbers, securely bolted together with rough machine bolts, which also carry the bolster chafing plates.



Steel Motor-Car Equipment of the Long Island Railroad—Motor Truck and Trailer Truck.

Both motor and trailer trucks were manufactured by the Baldwin Locomotive works.

The standard third-rail shoes on the Long Island cars are of the hinged-slipper type, supported on the usual wooden beam, which is clamped against the notched face of the equalizer spring seat castings, providing means for vertical adjustment. Upon the centre of the beam is placed a 600-ampere enclosed-type fuse in a wooden box, with a hinged cover and lined with asbestos.

Trains from the Brooklyn Rapid Transit Company's elevated lines operate over the Atlantic avenue and Rockaway Beach divisions by way of Chestnut Street Junction to Rockaway Park.

The Brooklyn elevated lines have been for some years operated by the third rail, but the location of their rail is twenty-two

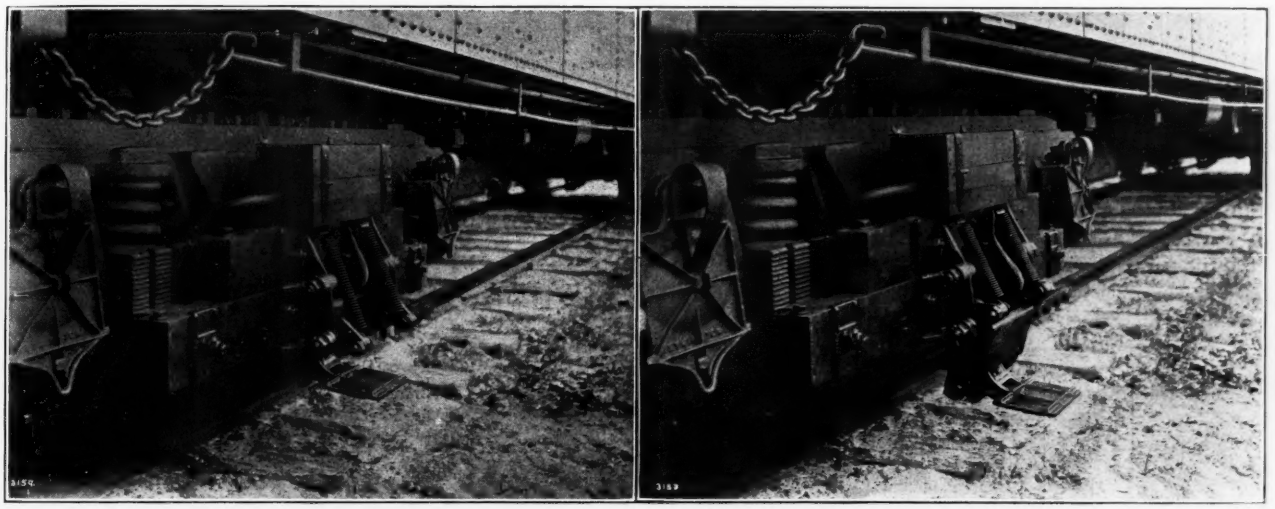
and one-quarter inches outside and six inches above the track rail, while the Long Island Railroad third rail is twenty-six

STEEL MOTOR-CAR EQUIPMENT OF THE LONG ISLAND RAILROAD—CAM FOR SHIFTING ADJUSTABLE THIRD-RAIL SHOE.

inches out and three and one-half inches up. This made it necessary to devise some form of adjustable third-rail shoe which would operate with equal facility over both third rails and be able to change from one to the other at reduced speed without requiring attention on the part of the motorman or train crew. Such an arrangement has been worked out, and patents on it have been applied for by James C. Boyd. It consists essentially of a hinged-slipper type of shoe mounted upon a movable lug which is held in either position by means of coil springs and is actuated by an arm that engages with a stationary cam mounted alongside of the track, in line with the third rail. The movement of the car past this cam in one direction changes the shoe from the inner to the outer low position, while a reverse movement of the car past the cam changes it from the outer to the inner raised position. These adjustable shoe equipments have been fitted to such cars of the Brooklyn Rapid Transit Company as are to operate over the lines of the Long Island Railroad.

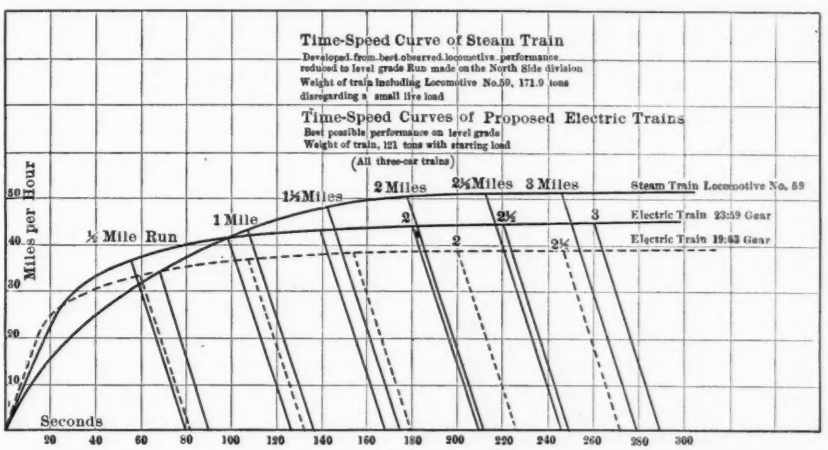
The cars are equipped with hand brakes and with the Westinghouse quick-service automatic air brake. This brake is of the new design developed from the quick-action brake. Compressed air is supplied to the system by a Westinghouse D-2 electrically driven air-compressor on each motor car, controlled by a standard Form "J" Westinghouse governor. This pump has a rated capacity of twenty-four cubic feet of free air per minute, and supplies both the air brake and the pneumatic control system, but the brake and the control systems are operated from separate reservoirs.

Careful investigation showed that the greatest flexibility would result from a two-motor-car equipment, using the most powerful motors practicable. The limitations were mainly the dimensions imposed by the largest trucks that could be operated under the conditions prescribed by the tunnel and curve clearances, which restricted the wheel base of the motor truck to six feet eight inches. This restricted the size of the motor to about 200 horsepower.



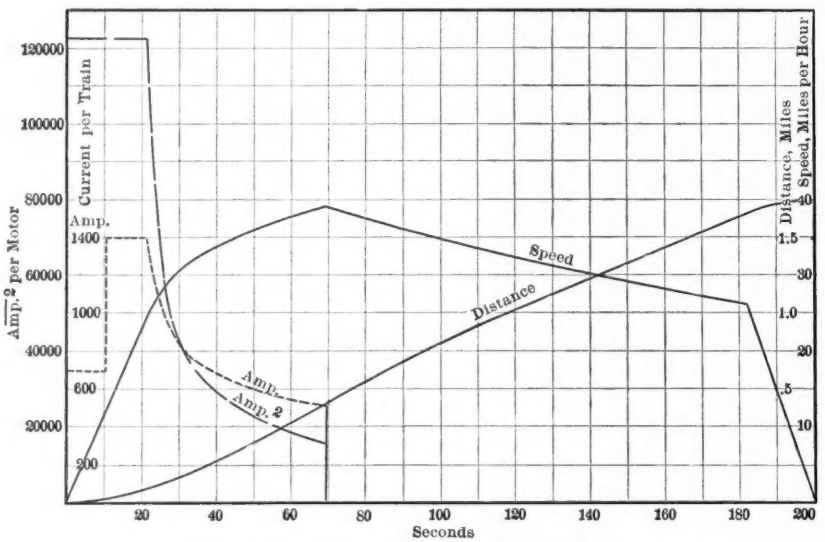
STEEL MOTOR-CAR EQUIPMENT OF THE LONG ISLAND RAILROAD—ADJUSTABLE THIRD-RAIL SHOE—INNER AND OUTER POSITIONS.

At the outset, a series of speed tests was made on various steam trains of the Long Island Railroad in order to compare the actual running time with that laid down



SPEED-TIME CURVES OF STEAM AND PROPOSED ELECTRIC TRAINS, LONG ISLAND RAILROAD.

in the time-tables, and with the times which the railroad officials desired to be met by the electrical equipment. An ordinary passenger coach was fitted with speed-recording devices and a number of speed curves were obtained. The best performance of a relatively light steam locomotive train, weighing 171.9 tons with the locomotive, is shown herewith. The difference in the running time of an equivalent electric train is shown in the same diagram, and in general indicates that for all average lengths of run between stops in suburban services up to about two miles, the electric train is the faster. The average length of run over the Atlantic avenue division, the first to be equipped, was originally estimated at 1.6 miles, but in practical operation since the road was equipped, this has been reduced to about one mile, giving the electric trains a still greater advantage in speed, due, of course, to their higher rate of acceleration.



TYPICAL SPEED-TIME CURVE OF 117-TON TRAIN.

The results given in table No. 1 show a comparison of steam and electric runs of average length, based upon the curves above mentioned, and others of similar character. The runs in this table are partly express and partly local; for the sake of simplicity the elapsed times of each run shown are those made by a three-car-train.

The general solution of the problem was worked out by the aid of speed-time curves, whose value for this purpose began to be recognized when electrical rapid transit problems first began to come up for solution on a large scale in connection with elevated railways. The general type of curve referred to is that shown herewith, now so familiar that it does not need explanation, which has the advantage of showing the instantaneous fluctuations of the current applied per motor, or for an entire train; and from this record of current fluctuation with regard to time, the average output in watts and the total power in watt-hours is easily computed.

The general result of the motor computations, as determining the size of the car equipment, was that a medium gear ratio (25:58 for the No. 113 Westinghouse motor) was fixed upon and the number of motor cars and trailers per train was recommended in accordance with the following table:

Length of Train.	Local.	Express.
2-car train	2 motor-cars	1 motor-car
	No trailers	1 trailer
3-car train	2 motor-cars	1 trailer
	1 trailer	2 motor-cars
4-car train	3 motor-cars	2 motor-cars
	1 trailer	2 trailers
5-car train	3 motor-cars	3 motor-cars
	2 trailers	2 trailers

DATA FOR SUBURBAN RUNS.

Run.	Distance, Miles.	Run, Letter.	Time, Minutes.	Train Sheet Schedule, Speed Entire Run.	Intermediate Number of Stops per Trip.	Time Out for Stops.	Average Length of Run, Miles.	Time of Average Run, Minutes.	A, Average Speed Between Stops, M. P. H.	B, Limit Average Speed Best Steam, M. P. H.	Ratio of A, B, % Steam.	C, Limit Average Speed Electric Train, 23/59 G. Ratio.	Ratio of A, C, % Electricity.
L. I. City to Port Washington.	18.18	a	41.5	26.3	7	4.5	2.27	4.62	29.5	36.0	81.9	35.5	83.2
		b	43.0	25.4	8	5.0	2.02	4.22	28.7	34.0	84.4	34.0	84.5
L. I. City to Whitestone Landing.	11.75	c	31.0	22.8	7	3.5	1.47	3.44	25.6	30.8	83.2	31.8	80.5
L. I. City to Rockaway Park.	16.3	d	39.25	24.9	5	2.5	2.72	6.12	26.7	37.5	71.2	36.5	73.2
		e	39.0	25.1	6	2.75	2.33	5.18	27.0	36.0	75.0	35.5	76.1
		f	40.0	24.4	7	3.5	2.04	4.57	26.8	34.0	78.8	34.0	78.8
		g	41.0	23.8	8	4.25	1.81	4.08	26.6	33.0	78.8	33.5	79.5
		h	43.0	22.8	10	4.0	1.48	3.55	25.0	30.8	81.2	31.8	78.7
		i	43.75	22.3	11	4.5	1.36	3.27	25.0	30.0	83.3	31.0	80.7
		j	47.0	20.8	14	5.5	1.09	2.76	23.7	27.0	88.0	29.0	81.8
L. I. City to Valley Stream.	22.97	k	59.5	23.1	11	7.5	1.91	4.33	26.4	33.7	78.4	33.7	78.3
L. I. City to Manhattan Beach.	16.1	l	37.0	26.1	3	3.0	4.03	8.5	28.5	41.0	69.5	39.0	73.0
		m	38.0	25.4	4	2.5	3.22	7.1	27.2	39.0	69.8	37.5	72.6
		n	40.0	24.2	5	3.75	2.68	5.87	27.4	37.5	73.2	36.5	75.0
		o	44.0	22.0	11	6.5	1.34	3.12	25.8	29.8	86.5	31.3	82.5
		p	39.5	24.5	7	4.0	1.98	4.56	26.0	34.0	76.5	34.0	76.5
Flatbush to Rockaway Park.	15.88	q	44.75	21.5	11	5.0	1.32	3.37	23.9	29.5	81.2	31.0	77.2
		r	45.5	20.9	12	5.75	1.22	3.06	23.9	28.5	84.0	30.0	79.6
		s	47.0	20.2	15	6.5	.99	2.53	23.5	26.5	88.6	28.5	82.5
		t	48.0	19.8	16	6.75	.93	2.43	23.0	26.0	88.5	28.0	82.2
Flatbush to Jamaica.	9.63	u	19.0	30.4	1	1.0	4.81	9.0	32.0	42.5	75.3	40.0	80.0
		v	23.0	25.1	5	3.0	1.61	3.33	29.0	31.5	92.1	32.5	89.2
Flatbush to Valley Stream.	22.55	w	60.5	22.4	13	9.0	1.61	3.68	26.1	31.8	82.0	32.0	82.4

6-car train	4 motor-cars 2 trailers	3 motor-cars 3 trailers
7-car train	4 motor-cars 3 trailers	4 motor-cars 3 trailers
8-car train	5 motor-cars 3 trailers	4 motor-cars 4 trailers

The Westinghouse electropneumatic multiple-control system was adopted for the cars of the Long Island Railroad.

The apparatus constituting the main control system comprises the following:

(a) Group of unit switches.
(b) Resistances.
(c) Electrically operated line-switch.

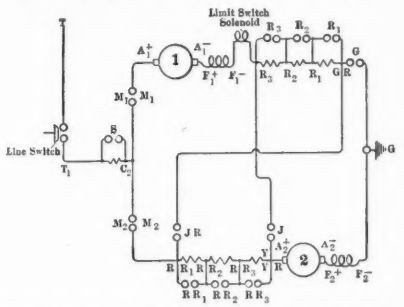
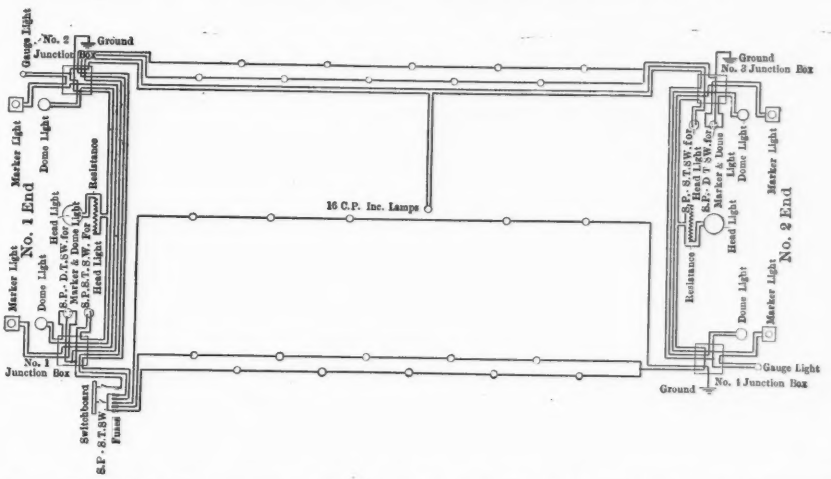


DIAGRAM OF MAIN MOTOR-CONTROL CIRCUITS.



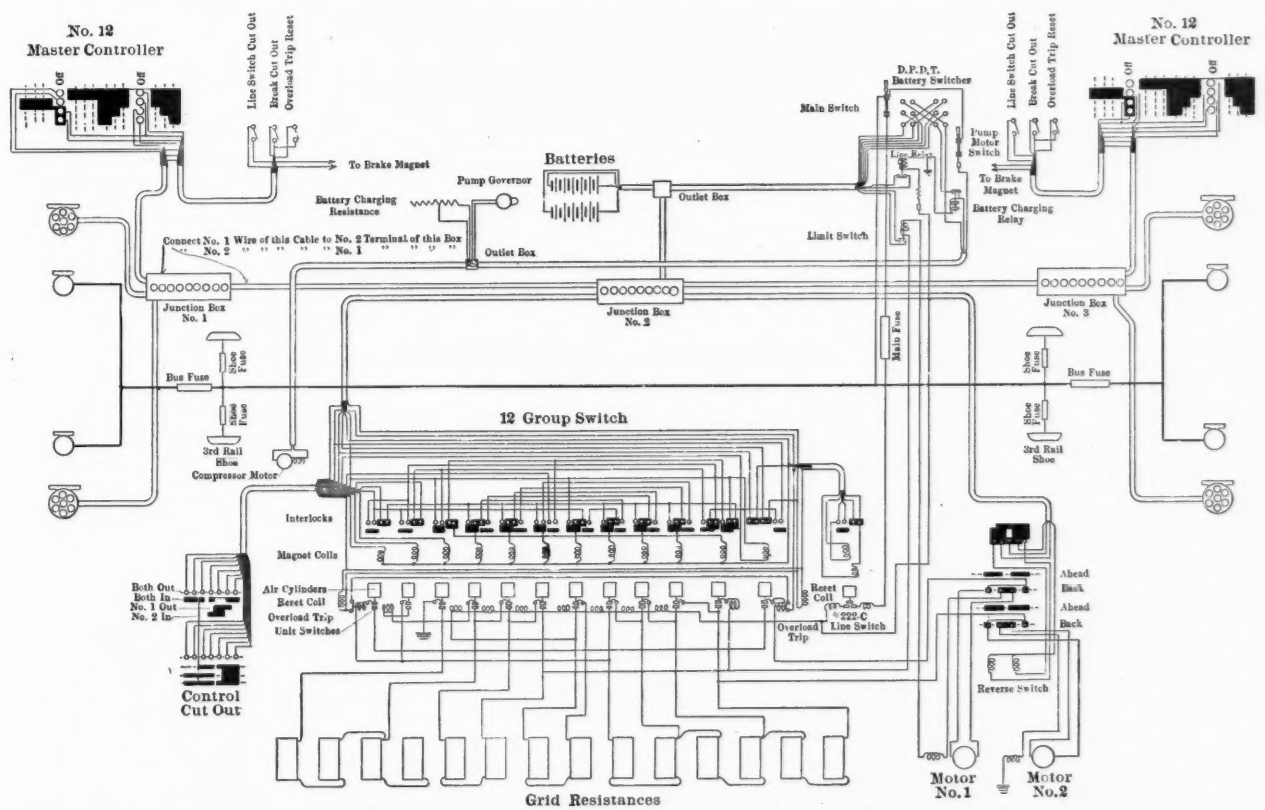
STEEL MOTOR-CAR EQUIPMENT OF THE LONG ISLAND RAILROAD. DIAGRAM OF LIGHTING CIRCUITS.

(d) Supply system, comprising the third-rail shoes, supply mains and bus line, connecting the main control apparatus on all the cars, including the necessary fuses and jumpers.

A diagram is shown of the wiring arrangements of the electric motor and control equipment, so disposed as to give a clear idea of the manner in which they are related to one another.

The diagram of the main motor control circuit is also shown. This shows only the connections from third rail through the line switch and the resistance to the motors and finally to the ground. The relative positions of the twelve unit switches forming the switch group are indicated by the following capital letters: "S," short-circuiting switch for switching resistance; M-1 and M-2, leading to the individual motor circuits; J and JR, bridging switches from one motor circuit to the other; G, ground-connection switch, and R-1, R-2, R-3, RR-1, RR-2 and RR-3, six switches which short-circuit six separate sections of the main rheostat.

For the sake of clearness, the reverse-switch connections are not shown in this diagram, it being understood that its sole function is to reverse the direction of the current through the armatures; for example, the diagram shows the armature connection A-1- directly connected to



WIRING DIAGRAM LONG ISLAND RAILROAD PASSENGER CAR.

A diagram is shown of the wiring arrangements of the electric motor and con-

switch M-1, with the A-1- directly connected to F-1-plus, the field connection of No. 1 motor. The function of the reverse switch is simply to interchange A-1-plus and A-1- and A-2-plus and A-2-, so that when it is thrown the direction of the current through the armature of motor No. 1 and also of motor No. 2 is reversed. In other respects, it is independent of the rest of the other switch connections.

The trailer cars are fitted with bus lines and their third-rail shoe connections for the main circuit, and also with the train line, including the necessary junction boxes and connector-sockets with the auxiliary-control circuit, these being necessary for connecting motor cars which are separated by a trailer.

The current for operating the control system in each car is derived from one of two small storage batteries consisting of seven cells each. These are so connected that one is being charged while the other is working upon the control circuit.

The batteries are charged from the circuit of the air-compressor motor. This is done by connecting the battery in multiple with an adjustable resistance so arranged that the proper charging current will pass through the batteries when the compressor is operated, the circuit through the battery being closed by a relay mounted on the switchboard panel.

The interior of each car is lighted by twenty-six sixteen candle-power incandescent lamps. Two sixteen candle-power lamps are placed in each vestibule in such a manner as to effectively light the platform and the steps. One sixteen-candle-power lamp is located in each marker, and a fifty-candle-power lamp is placed in the headlights, which are permanently fixed on the vestibule roof between the markers. Snap switches are placed within easy reach of the motorman for the control of the headlight, the markers and the platform lights. All other light and heater switches and fuses are located on the switchboard.

The cars are heated throughout with electric heaters of the panel type, each having a ventilated sheet-iron back and being placed under the seats. There are twenty-four heaters in the body of the car and at each end there is one of a special type in the motorman's cab.

The heaters in the steel motor-cars were supplied by the Consolidated Car Heating Company. Those in the wooden trailer cars were manufactured by the Gold Car Heating and Lighting Company, and are of the truss-plank type of construction.

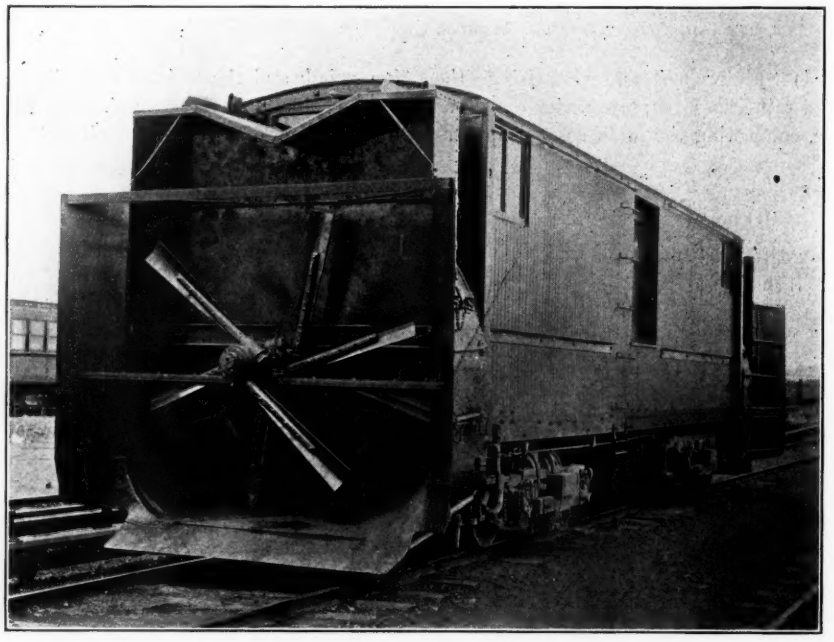
All wires and cables, for whatever purpose, are run in iron conduits. The sizes of wire used in the car wiring were No. 12 and No. 14 for the auxiliary control, and No. 0, No. 00, 144,000 circular mils and 250,000 circular mils for the main motor control circuit.

The steel cars as thus constructed and equipped have now been in successful operation for over a year.

Besides the steel cars above described, fifty-five wooden trailer cars, which had been built six or seven years previously with a view to using them in electrical trains, were equipped to run in trains with the motor cars; provisions had been made in designing these car bodies for conveniently disposing the electric-lighting circuits, but the class of work then in use was not considered safe now. These trailers are forty-six feet long and eight and one-half feet wide, over all. These wooden trailers had formerly been used in certain Long Island Railroad trains that had been run on the Brooklyn elevated lines between Flatbush avenue station and the Brooklyn Bridge. They have open platforms, side doors, and cross seats, and seat fifty-six people. They were wired for electric lighting and heater circuits and fitted with bus-line and train-line connections. The lighting and heater circuits are supplied by a connection tapped from the bus line through a fuse, and leading to a small switchboard panel from which the distribution is made. There are thirty sixteen-candle-power lamps in each trailer.

Five electric express cars were provided, equipped with the standard type of motor and trailer trucks, two 200-horse-power standard motors, and with the standard multiple unit-control apparatus. These cars are built of wood, fifty-two feet five inches over all in length, nine feet nine and one-half inches in width, and with roof twelve feet six and three-quarters inches above the top of the rails. They are equipped with standard Master Car Builders' couplers, and haul the old standard steam baggage and express cars as trailers.

Reference has been made in former articles[1] describing the substations, to the two all-steel portable substation cars which were designed to carry a complete rotary-converter substation of 1,000-kilowatt capacity, being so fitted that they can be used at a number of different places on the system on the Long Island Railroad where connections to the high and low-tension systems of distribution could readily be effected.



STEEL MOTOR-CAR EQUIPMENT OF THE LONG ISLAND RAILROAD—THE ELECTRIC ROTARY SNOW-PLOW.

A rotary snow-plow has also been provided, built by the Peckham Manufacturing Company, and equipped with one motor and one trailer truck of standard type, and all of the standard motor-car electrical equipment. A set of revolving blades with fan and housing is mounted at each end of the car, operated by one line shaft running through the car and fitted with two friction clutches, one for each end section, the centre section carrying two

[1] ELECTRICAL REVIEW, Vol. 48, No. 26.

fifty-horse-power railway-type motors, run by a series-parallel controller of the standard platform type.

The facilities for inspection and repair of electric cars of the Long Island Railroad system consist partly of a section of the original car shop at Morris Park, near Jamaica, which has been to a certain extent remodeled to better accommodate the new motive power.

At Morris Park, a new shop was built paralleling the old car shop, and with a transfer table situated between them. It is 216 feet long by 110 feet wide, and is connected with the mill that runs across the end of the old shop by a two-story structure containing space for pattern, upholstery and brass-finishing shops. The walls of the shop are built of brick and the roof is made in the saw-toothed form so commonly used for this purpose. There are thirteen pit tracks sixteen feet apart between centres. The shop is wide enough to accommodate two fifty-one-foot cars with a space between the ends of the cars, and three feet between the ends of the cars and walls. The pits are about twenty-six inches deep below the top of the rail. A transfer table is seventy-five feet wide, and long enough to accommodate the largest type of Pullman coach. The transfer table is operated electrically, and is provided with an electric capstan to assist in moving cars and trucks out of the shops.

Over the two tracks at the south end of the new shop there are light travelling cranes for handling the motors and axles, and facilitating general truck repairs. These cranes are of about five tons' capacity and are hand operated. Hydraulic jacks are used for hoisting the cars.

The original machine shop is already equipped with tools for turning wheels and axles, and for pressing wheels and gears upon the axles. The machinery used in the machine shop has since the beginning of electrical operation been operated by three-phase motors receiving current from the Woodhaven Junction substation, which is something less than a mile distant.

Besides the repair shop facilities at Morris Park, two inspection sheds have also been provided for effecting the periodical inspection and light repairs that are required to keep the cars in fit operative condition. The smaller of the inspection sheds is adjacent to the Rockaway Park Terminal.

The larger inspection shed is located at Dunton on the Jamaica Division directly west of Jamaica.

The Rockaway Park inspection shed will accommodate twelve cars, and that at Dunton, twenty-four. The latter station is provided with room for an office upon a gallery running across one end of the building, reached by an iron staircase coming up between the tracks.

The equipment of the steel passenger cars, the auxiliary stock, and the building of inspection sheds, were carried out by Westinghouse, Church, Kerr & Co., who, as in the other portions of the complete equipment, acted as constructing engineers. The entire work of design and construction was in charge of George Gibbs, chief engineer of electric traction of the Long Island Railroad.

With the preceding account of the electric car equipment, the description of the newly installed system for operating the Long Island Railroad trains with electric power is brought to a close. The car equipment has proved itself in every way equal to the demand made upon it both for regular and emergency conditions of travel. The electropneumatic multiple-unit control system has worked perfectly from the start, and throughout the entire installation, including the power station, transmission system, substations and cars the endeavor was made not only to take advantage of the most recent progress, but, as opportunity offered, to establish new precedents in the art. In achieving the distinction of being the first one of the main steam railroad lines to initiate and make effective the change of motive power for its suburban service to meet the needs of the territory, the Long Island Railroad Company has set an example of foresight, thoroughness and sufficiency in the execution of the undertaking.

The contract with the American Car and Foundry Company for the steel car bodies was let on January 20, 1905. The first car body was received at the Locust avenue shops for equipment early in April, 1905, and another one was exhibited at the International Railway Congress in Washington, D. C., early in May. By August 18, the entire number of steel cars had been delivered at the shops, where they were mounted upon trucks and all parts of the electric equipment assembled. During the summer the cars were equipped at the rate of ten per week. The first test of a completely equipped car was made on May 13, 1905. A month later, fully equipped trains were running on the branch between Jamaica and Springfield for testing the equipment, and for the instruction of the motormen. Regular electrical operation was first inaugurated between Flatbush avenue and Rockaway Park on July 26, 1905. Service between Flatbush avenue and Rockaway Junction was inaugurated on August 30. In October, the heavy excursion traffic to and from the Belmont Park race-track was successfully handled. On December 11, the electric service was extended to Far Rockaway and Valley Stream, and the use of steam locomotives for hauling passenger trains to and from the Brooklyn Terminal of the Long Island Railroad was discontinued.

On April 27, 1896, the act creating the Atlantic Avenue Commission passed the New York State Legislature, this being the formal beginning of the working out of a transportation problem that was of immediate and far-reaching importance to the citizens of Brooklyn and the Long Island Railroad. Several years elapsed before the results of the work, first of the Commission and then of the Board of the Atlantic Avenue Improvement, began to be noticeable, but it progressed year by year until finally consummated on the above date, a little less than ten years from its inception. The respective parts taken, first, by the Atlantic avenue commission in formulating a concrete plan of improvement of such far-reaching importance; and later by the Board of the Atlantic Avenue Improvement in planning and executing the work; and by the Long Island Railroad in cooperating with all the duly constituted authorities for the advancement of a plan so conducive to the welfare of the community served by it, have not been enlarged upon in the foregoing technical description of the work, but they are now matters of history, a full knowledge of which is available for other municipalities and corporations which may be confronted by similar problems.

But the record will be incomplete without an acknowledgment of the credit due to the late William H. Baldwin, Jr., president of the Long Island Railroad from 1896 to 1905, whose foresight, public spirit and initiative played such a leading part in the solution of a difficult rapid transit problem. Could he have lived but one year longer, he would have witnessed the consummation of his labors, which have conferred a lasting benefit on the community.

The New York Edison system now supplies, according to the *Bulletin*, installations aggregating 4,153,723 equivalents of sixteen candle-power, of which 122,234 horse-power are in electric motors.

LIVE STEAM HEATED FEED-WATER—ITS EFFECT ON THE OUTPUT AND EFFICIENCY OF STEAM BOILERS.[1]

BY G. WILKINSON.

(*Concluded.*)

Several experiments have shown that the rate of transmission of heat through the heating surface of boiling area increases largely as the draught of steam increases, and does not greatly depend upon increased temperature of the furnace, though, of course, the maintenance of the temperature of the furnace by an increased rate of combustion corresponding to the increased draught on the steam is necessary. Speculations on the nature of the act of evaporation which are put forward by Mr. Dales may not be out of place at this point. Taking the heat required for evaporation from a quantitative point of view, and assuming 100 pounds pressure absolute as a basis of argument, the total heat of the water from the abs: zero at the point of evaporation is 686 units per pound, whilst the instant after the total heat is 1,568 units per pound. Each atom of water which passes to vapor absorbs additional heat to 2.29 times the quantity which it contained whilst in a liquid condition. This absorption takes place with the rapidity of an explosive action, which readily explains the cause of the increased efficiency of boiling surface; and whether the extra heat is absorbed from surrounding superheated particles of water or from the plate of the heating surface, the sudden convection must lower the temperature of either one or the other source of heat. The resistance of the plate to the rate of transmission which either the water or steam is capable of producing is relatively small, and almost a negligible quantity. Following the previous argument, gentle boiling may be defined as a condition of the water where the process of evaporation is taking place at sparse intervals over the heating surface, while more or less violent ebullition is a condition in which the intervals between the vaporized atoms of water are closer, and if this speculation has a sound basis, it is evident that the rate of transmission depends on the maintenance of the supply of heat on the one side and the draught of steam on the other rather than upon any considerable increase or decrease in the difference of temperature between the source of heat and the evaporating water. That this is likely to be so is easily demonstrated by boiling water on a gas stove, from which the flame is at all times of about the same temperature. If it is desired to increase the evaporation it is necessary to burn more gas, the temperature of the flame being about the same in both cases. A suitable conclusion to this line of argument may be, that from boiling surface a quantity of steam can be obtained which is approximately proportioned to the quantity of coal consumed, and that this phenomenon is, within limits, practically independent of time. The limit of rate of evaporation evidently depends upon the possibility of maintaining a sufficient supply of heat to produce a condition of evaporation or boiling at the heating surface corresponding to the draught of steam, and it would appear that the provision of any considerable amount of heating surface over and above such as can be supplied by the furnace, with the necessary quantity of heat to produce boiling at the pressure, is largely futile and useless, and that a very plain and simple boiler when supplied with hot feed can reach the maximum of efficiency. What this maximum efficiency is depends, of course, on the temperature of the waste gases of the chimney and the weight of air per pound of coal consumed. Without useless tedium of illustration, perhaps the most authoritative figures may be quoted. An average sample of coal burnt with the theoretical minimum quantity of air produces 18.9 per cent of CO_2, and as other products are of negligible quantity, this may be taken as the highest standard. The most extreme percentage of CO_2 which has occurred in practice to the knowledge of the writer is sixteen. This would give an excess of air over the absolute theoretical minimum of $\frac{18.9}{16} = 1.18$, and as the theoretical minimum weight of air per pound of coal is about twelve pounds, $12 \times 1.18 = 14.17$ pounds of air per pound of coal. The total weights of the product of combustion per pound of coal burnt would in this case be 15.17 pounds, and if the products entered the chimney at 400 degrees Fahrenheit, with a specific heat of .2386, a waste would occur of 400 degrees—say, fifty degrees temperature of atmosphere = 350 degrees × .2386 = about eighty-four units per pound of products, which at 15.17 pounds per pound of coal = 1,275 units about per pound. Taking 14,200 units of heat developed per pound of coal, the available heat in this case is about ninety per cent of the total value of the coal, and deducting seven per cent for radiation, the remainder, or eighty-three per cent, would be the total efficiency of the boiler and economizer (192 pipes, Green's). This case, however, is very extraordinary, and was provided with mechanical induced draught, the rate of combustion being about eighteen pounds per square foot of grate area. The pressure in the boiler was also low, about sixty pounds.

There are few cases in practice where less than seventeen pounds of air are used per pound of coal, and this would give eighteen pounds of products of combustion, which at, say, 400 degrees Fahrenheit—fifty degrees Fahrenheit = 350 degrees Fahrenheit terminal temperature,

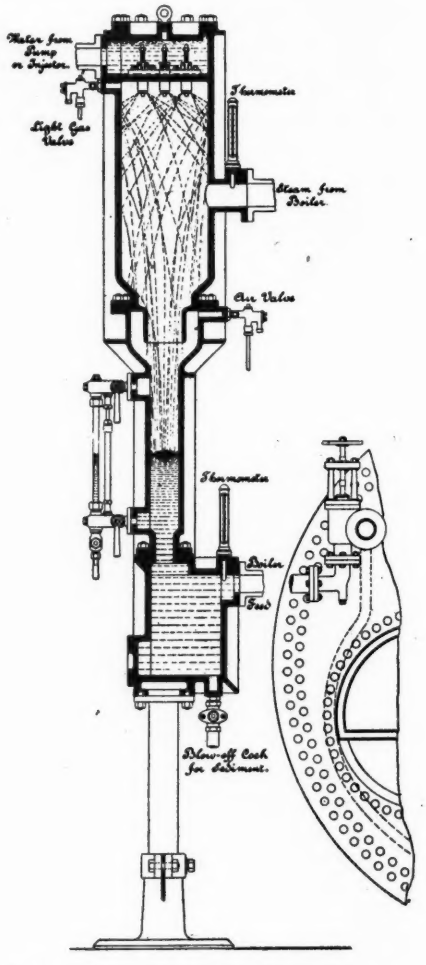


FIG. 1.—LIVE STEAM FEED-WATER HEATER.

would have again eighty-four units per pound waste heat to the chimney; and at eighteen pounds of products would carry off 1,512 units per pound of coal burnt. The available heat therefore at an ordinary maximum would be 14,200 — 1,512 per pound of coal, or 89.35 per cent, which, after deducting an allowance of seven per cent for radiation (which is perhaps rather low), the maximum efficiency in an unusual case of low air supply would be 82.35 per cent. It should be observed that no allowance in this

[1] Abstract of a paper read before the meeting of the Incorporated Municipal Electrical Association, London, England, June 22.

reckoning is made for infiltration of air to the flues, as regards the 400 degrees Fahrenheit terminal temperature of the products of combustion, and as this is usually great, the terminal temperature would not be much over 250 degrees Fahrenheit, this being as little as will give any sort of practical chimney draught even where it is induced by mechanical means.

In the case of the boiler of plain Lancashire type at the Harrogate electricity works, with which the tests appended to this paper were made, a set of comparative trials was made for ascertaining the extra efficiency of very high temperature feed as against the high temperature feed of a three-set economizer of Green's type containing 288 pipes. The temperature of the very high temperature feed was only ten degrees Fahrenheit below the steam temperature, and was made by the Dales & Braithwaite's live steam feed-water heater shown in Fig. 1. The temperature of the economizer feed supplied to the heater was 265 degrees Fahrenheit, already very high; and 218 degrees Fahrenheit above the cold water, which was forty-seven degrees Fahrenheit. The steam temperature was 358 degrees Fahrenheit, so that the heater had to supply ninety-three degrees Fahrenheit to steam temperature, and actually did contribute eighty-three degrees Fahrenheit.

The general conditions were reproduced as exactly as possible for the comparative test with the economizer only, and the net result was over seven per cent in favor of the live steam feed heater. With so little margin for improvement as existed in the efficiency of the boiler and economizer, the above result is remarkable, and as the tables of tests appended show, this live steam heated feed reached the maximum efficiency attainable under the conditions, the terminable temperature at the chimney bottom being lowered by infiltration of air to the flues, and the chimney draught was low, being an average of about 0.475 inch of water.

With greater differences between the economizer feed and the steam temperature, correspondingly greater improvement would naturally follow the use of full temperature feed.

The particulars of these trials, which were made at normal rates of combustion for Lancashire boilers, namely, 22.147 pounds and 24.27 pounds of coal burnt on the square foot of grate area per hour, are stated below.

1. Economizer and live steam heated feed:

Calorific value of coal, 14,200 B. T. U. per lb.
Rate of combustion per ft. sup. grate per hour, 221.47 lbs.
Steam pressure, 150 lbs. absolute temp., 358° F.
Economizer feed to heater, 265° F.
Heater feed to boiler, 348° F.

	Per Cent.
Efficiency of boiler and economizer from water at 47° F.	76.4
Efficiency of superheater	3.0
Radiation taken at	7.0
22 lbs. of air at 50° F. per lb. of coal = 23 lbs. of products at 400° F. + 50° F. (atmos.) = 350° F. above atmos.	13.6
Total heat of fuel	100.0

2. Economizer heated feed only.

Calorific value of fuel, 14,200 B. T. U. per lb.
Rate of combustion per ft. sup. grate per hour, 24.27 lbs.
Steam pressure, 150 lbs. absolute temp., 358° F.
Economizer feed, 234° F.

	Per Cent.
Efficiency of boiler and economizer from water at 56° F.	69.844
Efficiency of superheater	3.27
Radiation taken at	7.0
22 lbs. of air to 1 lb. coal; 23 lbs. products at 571° F. terminal temp.	19.886
Total heat of fuel	100.000

In the terminal temperatures given no allowance for infiltration is made; the quantity of gas leaving the boiler is calculated from the CO_2, which was about ten per cent. The actual terminal temperatures were much lower than shown by the figures.

Periodically, during the highest rate-consumption tests, a curious phenomenon was observed. The flues and economizers became full of burning gas at a red heat, which, being generally distributed, gave a periodical increase in the efficiency of the plant. Over 1,200 degrees Fahrenheit were registered at the economizer, after the three runs of the boiler flues had been traversed. This is very remarkable.

Concluding this section of the paper, the author ventures to say that hot gas more generally distributing the heat than is the case with fires immediately surrounded by water-heating surface, would conduce to the efficiency of boilers generally, and with a view to test this important point, he is fitting the furnaces of a Lancashire boiler with fire-brick lining and special air-inlet provisions for utilizing high-rate combustion in this manner.

The rate of combustion is limited by the temperature of the furnace, and only fire-brick lining can raise this to the necessary point for the rapid rates of combustion which are required.

The construction of the feed-water heater is shown in Fig. 1, which almost explains itself. The water is fed from pump or injector to spray valves in the upper part of the apparatus, which forms a steam chamber in direct open communication with the boiler steam at full pressure. Steam free of air or gas is maintained by constant slight blowing at the lower or heavy gas or air valve and also at the light gas valve in the upper part of the steam chambers. Air is, of course, about double the weight of steam of any given pressure, and it settles to the lower part of the steam chamber to be eliminated by the air valve, while lighter gases than steam, sometimes generated from bad water and often very troublesome in condensers, are eliminated from the upper valve. Without this arrangement the air and gases would accumulate, and both spoil the conductivity of the steam for heating and exclude the steam from the vessel by displacement. The water gauges indicate the level of the water in the heater, for comparison with that in the boiler.

The heated water overflows by gravity to the boiler from the top of the deposit vessel, and the separated incrusting matter is eliminated at the blow-off cock at the bottom.

American Navy Safety Appliances at Milan.

One of the few American exhibits at the Milan Exposition, now open for the season of 1906, is that of the "Long Arm" system of electrically operated bulkhead doors. The exhibit consists of a horizontal sliding door, a vertical sliding door, a hatch gear and the electrical emergency station, from which, aboard ship, all important bulkhead doors and the armor hatches are operated. The types of doors and the hatch forming this exhibit are all of the latest model. A great deal of interest has been manifested in Italy in the "Long Arm" system, which is in use on all the new warships of the United States Navy, and it is doubtless somewhat due to the educating influence of this exhibit that a movement has been started in Italy to have incorporated in the governmental regulations for passenger ships a clause making the installation of power doors obligatory.

Telharmonic System in New York City.

The first set of apparatus for the production of music electromechanically under the Cahill telharmonic system is being established in New York city under the supervision of J. G. White & Company, the wiring being done by the Lord Electric Company, of Boston, Mass. The plant is being installed in Park & Tilford's store on West Thirty-ninth street. The apparatus will be operated by a 200-horse-power motor, taking current from the Edison service. A second plant is now being constructed for shipment to the Pacific coast.

Electrical Notes from Europe.

(By Our Special Correspondent.)

ONE of the most important electrical enterprises which has been carried out in France is the system of electric tramway lines now in operation on the Mediterranean coast in the region of Nice. Some of the sections of the line, especially the part which lay in the suburbs of Nice, were constructed several years ago, and afterward different sections of tramway running along the coast were added, until at present there is a continuous line running from Cagnes, through Nice and Monte Carlo, and ending at Menton. This line is nearly thirty miles long altogether. Over it the cars run direct from Menton and Nice to Monte Carlo, without changing. The tramway system is operated in three sections—Cagnes-Nice, Nice-Monte Carlo and Monte Carlo-Menton. Of these lines the second is the one on which the greatest amount of work had to be done in laying out the route. Here the coast is made up largely of cliffs overhanging the sea, and the road had to be enlarged so as to accommodate the track, tunnels cut, retaining walls on the side nearest the sea constructed, and bridges built over the deep gorges which form the beds of the mountain torrents. This section has the heaviest traffic during the winter season, and the cars are run in some places at intervals of three minutes. Between Nice and Menton the line is double tracked. Broca rails, weighing 100 pounds per yard, are used for the track in general, laid flush with the road. In a short section the Vignole rails are laid on ties. The trolley line is supported upon bracket posts and lies over the centre of the track in some cases and in others at the side. The second or Cagnes section runs from the west suburb of Nice, then crosses the Var and follows the national road as far as Cagnes. A depot is erected at this latter point to accommodate the freight traffic, which is made up largely of products of the farms of the region, and special trains are run so as to bring the products into Nice at early hours. An important branch is the Contres line, which runs from the coast up the Paillon valley. Along the route is a large cement works, which assures the line at least 70,000 tons yearly freight traffic. These products are sent to the port of Nice or to different storehouses in the city which have special branches running from the main line. An arrangement is to be made with the railroad company which will establish connection between the port of Nice and the different railroad stations of the coast, as the railroad is also of narrow gauge (one metre). Over the tramway lines the trains will use a specially built form of tractor with four motors.

The current for the tramway lines is supplied from a number of substations which receive high-tension current at 10,000 volts and twenty-five cycles from the lines operated by hydraulic plants, and deliver direct current at 550 volts for the trolley. At present there are six of these substations working, and these are located at Nice, where there is a main substation running in connection with a steam plant; at Californie, midway between Nice and Cagnes; at Beaulieu, also in the suburbs of Monaco; and at Monte Carlo; besides the substation of Cap Martin, near the end of the line. The outfit of these substations consists in general of direct-coupled groups formed of synchronous motors working at 10,000 volts, and railway generators which supply 550 to 625 volts, with capacities of 250 kilowatts or less, or of rotary converters supplied from banks of transformers. These units range in capacity from 150 to 250 kilowatts. Batteries of accumulators are used in most of the substations.

The rolling stock at the present time consists of 100 motor-cars, three freight-hauling cars equipped with motors, and twenty-two freight cars, this apparatus having been in operation during the first period. Since then has been added an outfit consisting of six large motor-cars carrying two motors, twenty trailers of the closed type and twenty-two open cars. Later on were added twenty cars of a short type designed to be coupled in pairs and operated by one controller. This form of car was adopted with a view of going more easily around the sharp curves which occur on the lines. They are equipped with the multiple-unit system. The equipping of the tramway lines, as well as the substations, has been carried out by the Compagnie Française Thomson-Houston, the material coming from the Paris shops of the company.

The Paris Aerial Telegraph Company, of which M. Victor Popp is the promoter, has recently made an arrangement with the Roumanian government for installing four wireless telegraph posts, one on land and three others upon the vessels of the fleet. M. Popp recently informed the writer that this equipment was now complete and ready to operate. The contract was made between the Paris company and Lieut.-Commander Cesar Boerescu, inspector-general of the Roumanian maritime service, acting as a delegate of the government. The aerial telegraph station which forms the land post has been installed at Constanza and is well equipped with apparatus upon the Popp-Branly system, which has already been described. This apparatus uses the tripod coherer which Professor Branly brought out a few years ago. With this apparatus it is expected to signal for long distances, especially across the Mediterranean, either to other stations on the coast or to vessels. For charging the storage batteries the Constanza post is equipped with a direct-coupled generating group. The posts which have been placed upon the vessels Regele Caral, Principesa Maria and Romania, three in number, are each equipped with apparatus similar to the above, which will allow them to signal for more than 300 miles in the case of the Romania, which has masts of 105 feet height above the deck; for 300 miles in the case of the Regele Caral, using eighty-seven-foot masts, and as far as Constantinople for the third vessel, which is provided with sixty-five-foot masts. After the posts had been put in working order, the construction company left an engineer on the spot in order to instruct the personnel as to the operation of the system.

On the Continent, the Nernst lamp is manufactured principally by the Allgemeine Electric Company, of Berlin, which now has a large factory devoted to the purpose, and which is now producing the lamps in quantity by the most improved methods. One of the interesting features of the lamp factory is the testing laboratory, of which the accompanying view has been kindly furnished by the company. It is well equipped with measuring instruments of standard type, besides many other testing instruments which have been specially designed for use with the Nernst lamps. The various types of lamps which the company is now making will be observed here. Besides the smaller lamps,

which are built on the lines of the incandescent lamp, there is a type of large lamp which is intended to replace small arcs, especially for inside use.

At a recent meeting of the Société des Ingeniers Civils, M. Guillet brought out some points about the manufacture of steel in the electric furnace, according to the recent data presented to the mining and metallurgical section of the Rome Congress. On the Continent there has been considerable progress in the production of steel by the electric method. In Italy Commandant Stassans, who is one of the leading champions of the process, has been carrying on a number of researches in order to find the best and most economical methods. He claims to have been very successful with his recent processes, and recommends especially the use of the arc by reverberation. A new type of furnace built on this plan has lately been adopted by the Italian government, and is under the control of the war department. In other countries there is also considerable progress. The Froges-Heroult process may now be said to have passed beyond the experimental stage. Besides the large plant located at La Prag, using hydraulic power to give an output of 4,000 tons of steel, there are two other plants which have been lately erected. One of these is at Kortfors, Sweden, and the second is located in Germany, at Remscheid. Another large plant, which will soon be in operation, has been installed at Saut-Du-Tarn recently.

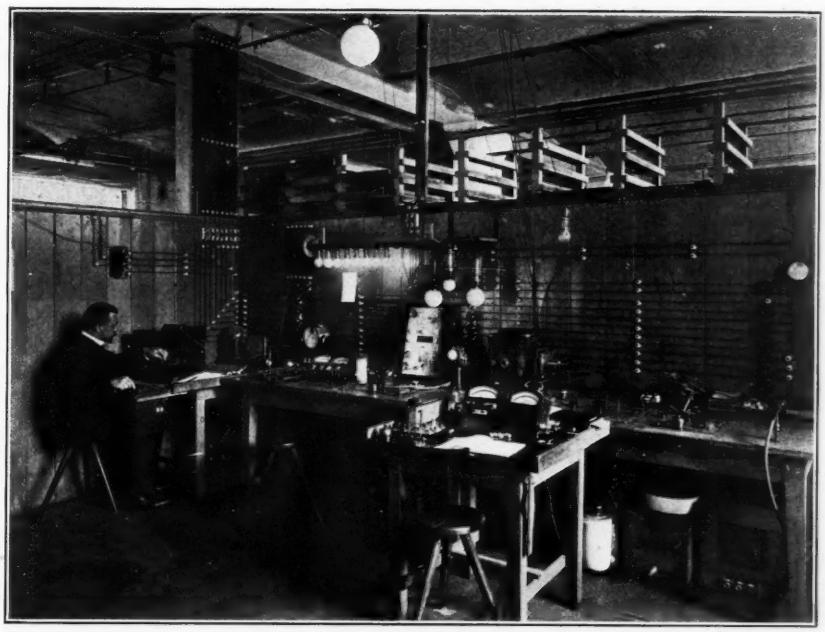
A new method which it is purposed to use at the German factory consists in first heating Siemens-Martin steel and then introducing it into the electric furnace, the latter carrying out the final processing of the steel, thus turning out a high-grade product. In this way it is expected to replace the ordinary grades of steel by a superior quality for use in general work, where heretofore the common grades of steel have been employed. It is found that the steel which is turned out by the Froges-Heroult process is superior to the ordinary steel, by reason of the fact that for an identical chemical composition, or, again, for an equal breaking strain, the new steel shows a greater elongation and a higher resistance to shock than the usual carbon steels, even including crucible steels. This is considered to be due to the neutral atmosphere which is obtained in the electric furnace and the absence of gases. Another point to be especially noted in regard to the steel made by the electric process is that it shows a much less deformation after tempering than other steels.

In this connection may be added some information, which has been given by O. Engelhardt, concerning the electric furnace plant erected some time ago at Gysinge, Sweden. This plant is operated on the Kjellin process, and is now turning out a good quality of steel. The furnace uses current to the extent of 170 kilowatts or more. Some trouble was found at first with the external protecting layer of the furnace. A silica composition had been used for this covering, but this was soon destroyed by the heat. It was replaced by a better covering which has a basic character and which is applied in a twelve-inch layer. It consists of a mixture of ten parts of magnesia and forty parts of Holland clay, with enough water to give a good stiffness. Some three tons of this mixture were used to coat the outside of the furnaces. As to the amount of metal which is now being produced at the Gysinge plant, it is stated that 285 tons of steel were turned out within twelve weeks, using an average of forty-eight charges of the furnace in eight days. The amount of power needed there is 770 kilowatt-hours per ton of steel. This amount may be reduced by placing in the furnace 0.72 ton of melted iron to 1.43 tons of cold iron, making the consumption only 650 kilowatt-hours per ton. The new furnaces, which are now building, are expected to lower the amount of current needed to produce the steel. This will not exceed 590 kilowatt-hours by the former method, or 490 by the latter. In the Gysinge plant the current used is 3,000-volt, fifteen-cycle monophase current, supplied by a hydraulic plant in the region. The production of steel can be carried out very economically, in view of the fact that the power can be supplied for $0.05 per kilowatt-hour.

At the Milan Exposition may be noted among the electrical features an international concourse relating to different methods of applying electric motors to agricultural implements, especially for plowing, and it is expected that a number of apparatus will be exhibited. A practical test of the motor-driven machines is to be held on a piece of ground near the city. The concourse is under the direction of the minister of agriculture, industry and commerce. It is to relate especially to the types of apparatus which are best adapted to fulfil the economic and agricultural conditions prevailing upon the Continent, and especially in Italy. The concourse was opened on the first of August and will continue to the end of the month. A special prize is to be awarded for the best apparatus. All the devices which are entered are to be put through an actual trial on the testing ground under the supervision of the jury. The extra labor which may be needed is to be furnished by the exposition.

C. L. DURAND.

Paris, July 28.



LAMP TESTING LABORATORY OF ALLGEMEINE ELECTRIC COMPANY.

The Indianapolis, New Castle & Toledo Electric Railway.

The state of Indiana, already netted with interesting systems of interurban railways, will soon have added to those now in successful operation a new line of electric railway between Indianapolis and New Castle, Ind., as the main terminals, with branch lines to Greenfield, Anderson, Muncie, Winchester and Richmond, the total mileage of which is as follows: Indianapolis to New Castle forty-five miles; Maxwell to Greenfield five miles; Shirley to Anderson sixteen miles; New Castle to Muncie twenty miles; New Castle to Winchester twenty-eight miles; New Castle to Richmond twenty-six miles; total, 140 miles.

The road will serve as the only means of railway communication with Indianapolis for a large proportion of the population reached by its service; in fact, no portion of the trackage is crossed by a competing railway. A private right-of-way, fifty feet wide, and terminal facilities controlled by the company in the city of Indianapolis, place the new system in a favorable position for maintaining high speed through the country, and secure rapidity of entrance and exit from the city proper. In addition to the passenger traffic, the company's franchise permits the transportation of freight without any restriction.

The engineering features of the road include the building and equipment of a main power station, located near New Castle, and ten permanent and one portable substations, one substation being installed in the main power plant building. The contemplated use of a portable substation is in keeping with well-established recent practice in general electric railway service. There are many interurban systems of which portions are liable at times to exceptionally severe loads, and the portable station is proving useful in dealing with them. It can readily be shifted from town as occasion requires, following up the shifting of spare cars and supplying additional power even at somewhat severe loss in the high-tension feeders.

The main power station will contain units of 1,000 kilowatts each, two Allis-Chalmers steam turbo-generating units being installed for present use to supply 25-cycle alternating current to the line by a system of step-up transformers operating at 33,000 volts. A line voltage of 33,000 volts was adopted, not only to meet the engineering requirements of the present system but also because the voltage at the frequency selected would enable the system to mesh properly practically all of the other similar systems now operating in Indiana, should future conditions so demand.

All transmission, both high tension and railway service, will be carried on pole lines, no third-rail construction being considered advisable.

Seventy-pound A. S. C. E. tee section rails, heavily ballasted, will permit of high-speed train operation.

The schedule so far prepared contemplates hourly runs between Indianapolis and Richmond, with connections for branch roads laid out to provide the most thoroughly satisfactory service. Limited high-speed service will also be established between Indianapolis and Richmond, operating on three-hour headway and making proper connections with branch roads. An express service is allowed for, as well, and two fifty-ton electric locomotives will be provided for freight haulage and switching purposes.

The contract for the entire construction of buildings and road-bed has been awarded to the Electrical Installation Company, of Chicago. Complete Allis-Chalmers power and electrical equipment will be installed in the main power station and three rotary converter substations, which will be built at once, the building of the remaining substations being delayed until later. The equipment for the main power station will, for the present, consist of two 1,000-kilowatt Allis-Chalmers turbo-generators to operate at 175 pounds steam pressure and fifty degrees Fahrenheit superheat, the electrical ends of these units being wound for twenty-five cycles, three-phase, 2,300 volts.

The boiler equipment will be made up of three horizontal water-tube boilers, 175 pounds gauge, with nominal rated capacity of 400 boiler horse-power each and fitted complete with mechanical stoking devices. Two boiler feed pumps are provided, each of sufficient capacity to handle the total amount of feed water necessary for operation of six 400-horse-power boilers at their normal rated capacity. The feed pumps are to be of the horizontal outside, centre-packed plunger type. A feed-water heater of the open cast-iron type will be provided, capable of handling 45,000 pounds of water per hour.

Two complete surface condenser equipments will be furnished, consisting of condenser proper, steam-driven air-pump and centrifugal circulating pump, direct connected to a simple engine, each outfit capable of condensing 20,000 pounds of exhaust steam per hour. Two Allis-Chalmers exciter generators will be furnished, one for each of the 1,000-kilowatt turbo-alternators. Six 350-kilowatt Allis-Chalmers oil-filled, water-cooled, step-down transformers for a ratio of 2,300 to 33,000 volts, are provided. They are to be arranged in two banks of three each for connection to the alternators. Three Allis-Chalmers converter transformers, each 150-kilowatt, oil-filled, self-cooled, step-down type for 33,000 to 405 volts, will be provided for supplying current to the 400-kilowatt, compound-wound Allis-Chalmers rotary converter to be installed in the main power plant, 400 kilowatts, twenty-five cycles, 405 volts, alternating-current to 650 volts direct current.

A forty-kilowatt, 120-volt direct-current Allis-Chalmers generator provided for direct connection to a high-speed engine, will be so connected as to form a reserve for either one of the two direct-connected exciters specified, so that, in case of the break-down of either one, the corresponding alternator will not be disabled. This generator will also furnish the station lighting.

The switchboard equipment for the main power station will be designed especially to meet the requirements of the service as laid out, with all the necessary protective apparatus and modern switchboard appliances.

The outside substations will each be provided with a 400-kilowatt, twenty-five-cycle, three-phase Allis-Chalmers rotary converter and three 150-kilowatt, oil-filled, self-cooled transformers, similar to those already described.

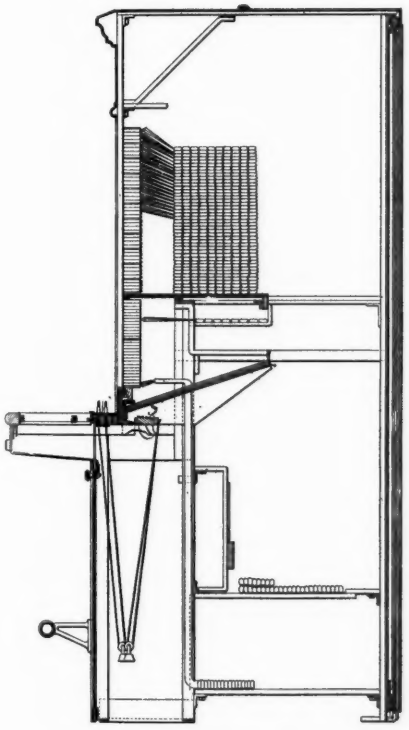
Eight complete Allis-Chalmers car equipments will be provided, each consisting of four seventy-five-horse-power railway motors, two controllers, Christensen air-brakes, one set of rheostats and miscellaneous apparatus.

The motors specified for the car equipments are of liberal design, provided with large bearing surface, and particularly adapted to heavy interurban service.

The controllers which have been developed for use with these motors are made suitable for two and four-motor equipments. They are of the series-parallel type, and are provided with an efficient magnetic blowout. The various combinations of motors and starting resistance are such as to give a smooth acceleration, and the controller operating handle may, if desired, be fitted with an automatic device which prevents the operator from notching the controller too fast and drawing an excessive current from the line. The buildings provided for the system are, in general, designed with a view to rapid additions to the initial equipment when necessary.

Electrical Patents.

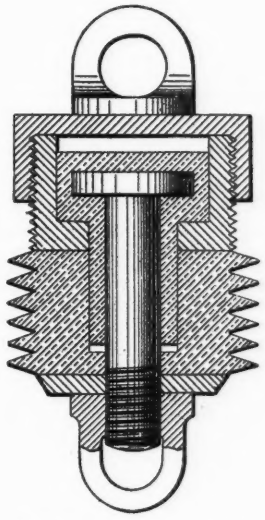
Benjamin F. Merritt, East Orange, N. J., has obtained a patent (826,680, July 24) for an improved multiple-switchboard construction, which he has assigned to the New York Telephone Company. The object of the invention is to more securely separate and individualize the different sections of the switchboard and guard against the spread of incipient fires which are liable to be started at the cord shelf connections, in the cabling, or in the branches or extensions which connect with the multiple jacks of the subscribers, or in fact in any part of the conductors or their connections. This is accomplished while at the same time securely supporting the several parts of the switchboard frame. The invention consists in the combination



MULTIPLE SWITCHBOARD CONSTRUCTION.

with a cord shelf, of connecting cords hanging from the shelf spring jacks in the face of the board above the shelf, cables at the rear of the switchboard, skinners extending forward from the cables to the spring jacks, horizontal partitions separating the spaces occupied by the multiple jacks, the answering jacks and the connecting cords from each other and transverse vertical fire-resisting bulkheads or partitions extending forward at intervals from the line of cables and dividing the spaces occupied by the skinners and connecting cords into separate compartments.

Max Meirowsky, Cologne-Ehrenfeld, Germany, has obtained a patent (826,589, July 24) for an improved electrical insulator. The present invention relates to an insulator for the trolley wires of electric tramways, for high-potential conductors, switches, implements, tools and



ELECTRICAL INSULATOR.

the like, laminated insulation, particularly mica, being preferably employed. The utilization of laminated insulation, especially of mica, hitherto offered great difficulties, in the case of conductors in the open. These difficulties are overcome in the case of the present insulator, in the first place, by the laminated insulation being surrounded by a cap, preventing the loosening and coming apart of the laminations, or by mica rings, and, in the second place, by both metal parts and also the parts of the insulation being so arranged and formed that the non-uniform forces which come into action, particularly in the case of trolley wires, exercise no injurious effect on the parts of the insulation, and these parts in case of need can be easily separately exchanged. Moreover, care has been taken to provide as large an insulation surface as possible, in order to prevent leakage currents. The invention consists in the combination of a metal cap having an opening at its end, a metal member having a head portion and a shank portion, the head portion lying in the metal cap and the shank portion projecting through the opening in the cap, and having a screw thread, insulating material surrounding the metal member and partly surrounded by the metal cap, insulation consisting of mica rings having furrows in their circumferences surrounding the above-mentioned insulating material surrounding the projecting shank portion of the metal member, and a nut on the screw thread of the shank pressing the above-mentioned mica rings against the end of the metal cap.

BOOK REVIEW.

"The Wire Tappers." Arthur Stringer. Boston. Little, Brown & Company. Decorated cloth. 324 pages. 5½ by 8 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $1.50.

Apart from any value this book may have as a story, it will be read with considerable interest by a great many who have known of wire tappers by reputation, but who have no conception of what their calling means. The hero is a broken-down telegraph operator who has, through force of circumstances, drifted into nefarious practices. Once having fallen under the ban of the law it is difficult for him to make an honest living, and upon being discharged from custody he affiliates himself with a sporting gentleman who has urgent need of his services. In the employ of this person he meets the heroine, who, for some reason or other (the story never divulges the secret) is under the influence of this wire tapper and card sharp. This unfortunate pair endeavor to escape from the quagmire into which they have drifted, and the story of their operations, interspersed with more or less technical descriptions of the apparatus used and the methods followed, is quite interesting. The story, of course, has a happy ending. There is hardly any danger that any one will try to emulate the hero's wire-tapping exploits, for now that the Western Union and telephone companies have been given a chance to see the inside workings of such a scheme they will be on the lookout.

Electrical Accidents.

The annual report of the chief inspector of factories and workshops in Great Britain for the year 1905 includes a report from G. S. Ram, the electrical inspector of factories, on accidents due to electrical causes. The number of fatalities reported during the year was thirty-two, of which number seven were mechanical accidents. The number of non-fatal accidents amounted to 370, half of which were due to mechanical causes. Of electrical accidents at stations of electricity supply companies nine were due to arcing of switches, two of these from mistakes on the part of injured persons, and six to bad design or faulty apparatus. One was due to insufficient working space in front of a high-pressure board. Two were caused by the arcing of fuses, one being an oil fuse. One accident, which occurred when working close to live conductors, shows the danger of the common practice of locating fuses for small instrument transformers in places where they can not be got at without danger of coming in contact with exposed conductors at high pressure. With regard to accidents at private generating stations, none was fatal.

Reviews of Current Engineering and Scientific Literature.

Some Causes of Error in Photometry.

Lancelot W. Wild holds that few photometrists properly appreciate the importance in photometry of the elimination of angularity errors. In general the art of photometry may be said to consist in judging the illumination of two contiguous surfaces, each being lighted from a separate source. A perfect screen may be defined as one which appears equally illuminated at no matter what angle it is viewed, the illumination being also exactly proportional to the cosine of the angle from the perpendicular at which the light rays strike its surface. It is hardly necessary, however, to say that such perfect screens do not exist outside the domain of mathematics. The apparent illumination of a screen varies slightly with the angle of view. From tests made by the author it would appear that with the screen under observation the best angle of view is at about fifty to sixty degrees. For very accurate work it is advisable to fix the angle of view accurately. There are very few photometers in use the carriages of which can not be deflected from the perpendicular by one degree. This would increase the illumination of one surface by three per cent, and reduce that of the other by three per cent, making a total error of six per cent. Errors are also caused by incorrect alignment of lights. A displacement of one-half inch, either vertically or horizontally, is by no means abnormal when ordinary incandescent lamps with irregular filaments are dealt with. Even if arrangements are made for moving the lamps in all directions, with a view to bringing them into exact alignment, it is difficult to judge sufficiently exactly the true photometric centre of the filaments. With a photometer screen so arranged that the ray shall fall perpendicularly upon the surfaces to be viewed, the error due to a want of alignment is quite negligible, a displacement of one light by one-half inch in thirty inches producing an error of only 0.02 per cent, this being the difference between the cos 0° and cos 1°. To avoid the angularity error, the two surfaces to be viewed must be absolutely parallel, so that side play between carriage and bar may affect the illumination of both surfaces in the same direction and to the same degree. Both surfaces must be normally perpendicular to the light rays falling upon them, so that, should their light be out of true alignment, the effect upon the illumination would be negligible. The surfaces must be viewed through a tube, so that the angle of view can not become changed to any appreciable extent. A telescope answers the purpose very well. Having these general principles in mind, the writer proposes a flicker photometer quite free from angularity errors. This consists of a special form of Bunsen disc revolved by an electric motor, and viewed by the agency of a mirror and telescope. The disc is cut out of ordinary white blotting paper and has about half of its surface treated with white paraffine wax, so that half the disc is opaque and reflecting, the other half translucent and diffusing. The disc is revolved on its centre by means of a small motor. A small portion of the upper part of the disc is viewed through a mirror and telescope. The object of using a telescope instead of a simple lens is that if no diaphragm is used the eye finds it difficult to keep in focus on the disc, which, when revolving, shows no detail. As arranged, an image of a portion of the revolving disc is formed in the air, so to speak, inside the diaphragm. The eyepiece is adjusted until the diaphragm appears in focus, and thus the eye is automatically trained upon the revolving disc. Keeping the disc in absolute focus increases the sensitiveness of the photometer, and, at the same time, reduces the fatigue to the eye. These photometers have been tried tilted as much as ten per cent out of true, and with one or both lights as much as six inches out of alignment. Within the limits of experimental error (about one-half of one per cent) no angularity error has been found.—*Abstracted from the Electrician (London), July* 20.

The Control of Tram-Cars on Gradients.

The four most recent accidents in Great Britain all occurred through a car getting beyond control while descending a gradient. The need of brakes which can be absolutely relied upon to control the car on any grade is unquestioned. The types of brake in general use on tram-cars consist of the ordinary wheel brake, applied by hand power; the rheostatic brake deriving its power from the momentum of the car driving the motors as generators, the current derived in this way passing through an external adjustable resistance; the mechanical slipper brake, which consists of some form of slipper or shoe carried on the car, which is pressed against the track rails by means of powerful levers or screws; and the electromagnetic slipper or track brake, which consists of a powerful electromagnet suspended on the car in close proximity to the track rails, deriving its power from the momentum of the car driving the motors as generators, the current thus generated being passed through the coils of the magnetic brake. Its operation is entirely independent of the line current, and is unaffected by loss of contact between trolley wheel and wire. Tests carried out by A. L. C. Fell, chief officer of the London County Council's tramways, prove that the electromagnetic brake is the most powerful, safest and most easily manipulated. Perhaps the most useful feature of the electromagnetic track brake is its ability to control a car descending a gradient. It is possible with this form of brake to allow the car to descend a hill at practically any desired uniform speed. In order to do this it is necessary for the driver to set his controller handle at any of the brake notches on his controller. This will bring the car to a definite speed, and it will continue at that speed as long as the controller remains in the corresponding position. The successful operation of any form of brake can only be attained if the wheels continue to revolve. Should anything occur to lock the wheels, all forms of car brakes at once become inoperative. The retarding force to the car then consists only of the friction between the wheels' circumference and the track, and in most cases this is not sufficient to control the car once it has attained a certain speed. Unfortunately, experience has shown that in many cases accidents have been caused through a too strenuous application of the brakes. It would seem, therefore, that every effort of inventive skill should be directed toward the development of such appliances as will prevent the locking of wheels, so as to allow the present known powerful forms of brake to operate when they are called upon. The perfection and development of the electromagnetic brake has unquestionably contributed largely to increased safety, but even with this brake the human element can not be entirely eliminated. If placed in the hands of

an inexperienced or careless driver the most efficient form of brake is of little value, because when most needed there is no definite assurance that it will be manipulated properly.—*Abstracted from the Tramway and Railway World (London), July 12.*

The Nickel-Iron Accumulator.

The experiments of Herr J. Zedner demonstrated that the nickel electrode of the Jungner-Edison cells did not contain any otherwise unknown nickel peroxide, but only the long-known sesquioxide, Ni_2O_3. The amount of hydration by the oxide was left uncertain, however. By comparing the water-vapor tension of this hydrate to the water-vapor tension of sulphuric acid of twelve graded concentrations, Zedner has found that the hydrate, $Ni_2O_3 3H_2O$, is stable when the vapor tension of the sulphuric acid is below three millimetres of mercury; and the hydrate, $Ni_2O_3 6H_2O$, is stable when the tension is above six millimetres. An intermediate hydrate was not observed. The caustic potash of the accumulators appears to contain the hydrate, Ni_2O_3-$6H_2O$, which is called the nickeli-hydrate, and generally written $Ni(OH)_3$. This is the oxide contained in the pockets of the charged electrode. The electrode potential, measured against a hydrogen electrode, diminishes when the concentration of the caustic potash increases, and the temperature coefficient of this potential is negative with 0.0007 volt per degree centigrade. The discharge of the cell, all investigators have agreed, occurs in two steps: the first at about 1.3 volts; the second at about 0.7 volt. Zedner finds that during the first step some nickeli-hydrate is reduced to nickelo-hydrate, $Ni(OH)_2$. The second step is not connected with the formation of some other oxide, and appears to be due to the discharge of the oxygen which is occluded by the electrode during the charge. It has been noticed that the nickel electrode liberates some oxygen during the period of charge. More oxygen seems to be occluded by the graphite which is added to the nickel oxide to increase its conductivity than by the nickel oxide. The evidence on this point is conflicting. An electrode not containing any graphite, especially prepared by the Kölner Accumulatorenwerke G. Hagen, did not indicate any second step at all, but an electrolytically prepared electrode of Zedner's, also free of carbon, showed it. The behavior of the electrodes when in a partial vacuum and when submitted to alternate discharges and charges supports the view that the oxygen liberation is an essential feature. When the discharge is suddenly turned into a charge, the potential of the nickel electrode rises slowly on the first step of the curve, but abruptly on the second step. In the first case the rise depends upon the naturally slow diffusion of the alkali from the pores of the nickel oxide back into the cell. In the second case, the beginning of reoxidization is at once marked by the high potential. The behavior of the nickel electrode is now fairly understood, though it should at once be mentioned that Ballucci and Clavari, contrary to Zedner, deny the existence of the oxide, Ni_2O_3. What is wanted now is a systematic investigation of the iron electrode, which is rather difficult to oxidize outside the cell, but is generally credited with twice the capacity of the nickel electrodes and with a one-step potential curve. Gräfenberg, on the contrary, seems to ascribe the two steps to the iron electrode. There is no doubt that the electrolyte—the alkali—is concerned in the reaction, though not to the same extent as the acid in lead cells. At the same time, most of the active material is, in both cases, ballast, as the reactions do not penetrate deeply. In practice we hardly obtain more than thirty watt-hours per kilogramme of cell weight in lead cells, and twenty-four in nickel-alkali cells.—*Abstracted from Engineering (London), July 20.*

The New Close Works of Ernest Scott & Mountain, Limited.

The new Close works of Ernest Scott & Mountain, Limited, are situated adjoining the Northwestern Railway from Newcastle to Sunderland. Their total area is nearly seven acres, two of which are under cover. A direct siding is provided to the Northeastern Railway, and full-gauge tracks to the extent of about a mile are laid throughout the works. The light machine shop, which forms one of four main bays, is 234 feet long by thirty-four feet wide, and includes the whole of the light machinery, such as small lathes, slotting and milling machines and other tools of this description. It is served by a hand crane of five tons capacity. By the side of the light machine bay is the heavy machine bay, the total length of which is 558 feet, and the width forty-three feet. It is intended that the light machine bay shall be extended to the same length as this shop, and the original plan for the works contemplates the erection of two further bays of the same length, on the west of the present building. The large bay comprises the heavy machine tool shop, which is situated at the north end; the core-building department, in the centre, and the general erecting shop and light fitting department, at the south end. The far end of the shop is devoted to the final testing of all classes of machinery. The testing department includes a very complete equipment for the testing of high-speed engines, dynamos of all kinds, including continuous-current and three-phase machines, electric motors, three-throw and centrifugal pumps. Adjoining this bay is the electric and brass shop, in which the whole of the armatures, field magnets, commutators and other electrical details are constructed. This bay is 264 feet long by thirty-four feet wide. The adjoining shop, of the same size, is devoted to general stores, including finished and unfinished stock, electric cable, steel stampings for armatures, switches, switch gear, etc. At the north end of this bay is the drying and varnishing department for the armature sections and magnet windings, which are constructed in the adjoining electric shop. The foundry is situated a few yards distant from the stores. This building is 175 feet long by 112 feet wide. There are two cupolas with a combined capacity of eleven tons per hour. The air blast is supplied by a Roots blower driven by a fifty-two-horse-power electric motor. At the back of the cupolas are a number of beams, over which a siding is carried, so that the foundry materials can be deposited inside the building with a minimum of trouble. The brass foundry, which is under the same roof, comprises four pot holes and a small drying stove. The boiler house adjoins the foundry. The equipment includes a modern Babcock & Wilcox boiler working at any pressure up to 300 pounds per square inch. There are also two locomotive boilers, which are used for testing purposes and to supplement the larger boiler at times of pressure. The generating station includes a vertical long-stroke compound engine capable of developing 250 indicated horse-power. This drives by belt a compound-wound, continuous-current generator running at 110 volts, with an output of 120 kilowatts. There is also a combined high-speed compound engine with a direct-connected dynamo of forty-five kilowatts capacity. The artificial lighting in the works is by means of arc lamps, each of 1,000 candle-power, the total number installed being seventy-two. A large number of incandescent lamps is also provided for separate tools, offices, etc. The heating of the shops is done by live steam carried throughout the whole of the buildings in specially constructed pipes with radiating grids.—*Abstracted from the Engineering Times (London), July 19.*

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

ORGANIZATION AND CONDUCT OF A NEW-BUSINESS DEPARTMENT SUITABLE FOR CENTRAL STATIONS IN CITIES OF 50,000 POPULATION AND UNDER.

(Concluded.)

BY S. M. KENNEDY.[1]

Soliciting—Advertising in the electric business is principally to arouse curiosity and invite investigation. Its object is to induce the reader to ask questions, and prepare the way for getting business. But it requires a personal interview to close a contract, and the prospective consumer must either hunt some one up, or some one must hunt him up in order to bring matters to a desirable climax. It is a good plan for a representative of a company to do the hunting. The man who reads the advertisement might have good intention, but a bad memory.

"The best cause requires a good pleader," and the best-managed new-business department requires good solicitors. There are some lines in which a solicitor requires only to be a good talker. Not so in selling light and power. A good talker is all right, but he must first be honest, earnest and straightforward, and what he says must carry with it the ring of truth. The solicitor goes out among the public. He meets the people in their homes, offices and places of business. He does not represent himself, he represents the company, and the public is going to judge the company by the action and words of the solicitor. Often he is the only one about the company whom the customer knows.

Regular Solicitors' Meeting—There is a great difference between a man coming to you to do business and you going to him. The first presupposes a desire in him to act; the second a desire in you to induce him to act. Consequently, solicitors should be trained and instructed. In this connection it is well for the manager of the new-business department to gather his staff around him at least three times each week to discuss matters in hand, to answer questions and smooth out difficulties. New conditions are constantly arising which require to be met. Information is constantly coming in which requires to be distributed. Reports about new buildings, new building permits and new tenants must be dealt with, and often a daily meeting is necessary—and advantageous. Direct solicitation is the safest and surest way to obtain business, and the solicitor must be equipped for his work. The electric company has much to do to overcome competition, indifference and inertia, and it is through the solicitor that a large amount of this active and passive opposition may be removed. He must educate and demonstrate. He must make the public realize that what his company is selling is something in which every one should be interested; something that lessens the cares and responsibilities of life; something that is superior to everything else for doing similar things; something that reduces work, lightens labor and saves their pocketbooks from certain ravages.

Solicitors' Tactful Work—It is essential that solicitors should not be too technical in their talks with prospective consumers. There is nothing to be gained in befogging a man by injecting into a conversation a mixture of amperes, ohms and volts. The solicitor is not selling kilowatts; he is selling light. He is not selling amperes, he is selling heat and power. If he has acquired technical knowledge, let him forget it when talking to an ordinary man or woman, and he will sell electric current with less trouble. Those engaged in the electric business are apt to forget that the public does not know as much about it as they do. It is a fact that a very large percentage of the community does not know of the conveniences and simplicity of handling the current—even when they have it for lighting their homes. Many people have a fear of electricity on account of its mysterious nature; some thinking it as dangerous as lightning. Here is where the careful work of the solicitor may do good every day.

To the merchant the solicitor points out the advantages of electric light for showing his goods. For keeping his ceilings and store clean, by an absence of smoke and smut, for reducing the heat in summer and permitting good air at all times. For improving the decoration of his windows and keeping them clean winter and summer, so that the public may see what he wishes to display. And then he shows him the score of electrical devices which may be operated to advantage inside his store, and help him make money. And, lastly, the solicitor takes his merchant to the door and points out how and where an electric sign will work for him while he sleeps; how he can burn his name and business into the public mind, and how the company will take care of the sign, turn the current on and off at the proper times and relieve him of all responsibility in the matter.

The power user has much to learn, and to a great extent the solicitor must be his instructor. He goes into a factory in the crowded part of the city, and what does he see? Probably fifty per cent of the power generated wasted and dissipated in shafting and belting before the machine commences to work. Probably ten times as much space as is necessary given up to engines and boilers—and valuable space, too. Probably twice as much money invested in the power end as there should be, and, consequently, twice as much interest and insurance, and four times as much depreciation continually piling up. He probably finds plenty of noise, smell, dirt and inconvenience, to say nothing of high-priced skilled labor to keep the wheels moving. Little by little the solicitor can show that electrically driven machinery represents economy of power by means of direct-connected units; that motors occupy little space, and may be taken off the floor and stuck on the walls and ceilings; that they cost less than half the price of any other kind of power machinery; that they are clean, noiseless, convenient and reliable, and do not require skilled labor to operate them.

Appliance Showroom—The work of the solicitor may be greatly aided by the company having a showroom in which all kinds of electrical appliances, big and little, may be seen and their usefulness and convenience demonstrated. The public may thus become familiar with the workings of the different apparatus, and the solicitor will have an advantageous place to which he may invite prospective consumers, and there explain the actual operation of what he wishes to sell. Too

[1] General agent, Edison Electric Company, Los Angeles, Cal. Winner of the $300 prize offered by the Cooperative Electrical Development Association.

much care and attention can not be given in the arrangement and fitting up of this room. Lamps of every size and design should be tastefully displayed so as to obtain the best effects out of each. With them there should be shown the current-saving devices, and also electric motors in operation. The latter will help to educate the people to be familiar with the meter's mechanism, and tend to inspire confidence. Then there should be specimens of all sorts and varieties of practical appliances which may be used in the house, office, store and workshop. In short, a continuous exhibition of what may be had in electric apparatus and what may be done with them. In this showroom there should always be plenty of small booklets, giving illustrations and concise information regarding the different kinds of appliances, so that those inspecting them may have something to carry away to refresh their memories and arouse the interest of others.

Electric Office Display—But the manager of a central station must show his belief in what he produces and sells by using freely what he wants others to buy. He preaches that an electric sign is the best kind of an advertisement. Does his company use one?

He advocates a well-lighted store and a brilliant window. But how about the company's office? Is there plenty of light, and is it burned far into the night? Has he electric fans, foot-warmers and radiators installed for the benefit of employés and customers? What is the use of his saying that "trade follows the light" if he does not illuminate his own premises. If he has no electric sign over his office, what is the use of his preaching that the same law which draws the moth to the flame of the candle also draws the buying public to the brilliantly lighted store. Let deeds as well as words show that he has plenty of confidence in his own product.

System—It was Thomas A. Edison who said that "genius is partly inspiration, but mostly perspiration." In other words, energy is what produces results. But much energy may be lost because it is not systematically applied. The manager of a new-business department will find that system is a good servant for him to employ. The larger the business transacted, the better must be the system, and that system is best which substitutes knowledge for guesswork, and economize time, labor and money. There must be system in advertising, and system in laying out the work for solicitors. There should be system in noting the results of advertising and the returns which solicitors bring in. There will be inquiries, leads and prospects, the data concerning which requires to be kept up-to-date and accessible. There should be system in handling what has to be done, and what has already been accomplished. System in noting sales, terms, proposals and contracts—records of buildings to be constructed, names of owners, contractors and tenants, and the particulars regarding the probable requirements of each. In records of prospective power consumers, complete information is necessary about present installations, kind of machinery, makers' name, horse-power, use and hours of operation.

Care of Customers—In all branches of the new-business department's work, system is needed, but not the kind of system which becomes a tax and a burden. The longer he is at his work, the longer he is dealing with the people, and the longer he is trying to sell electricity, the more will the new-business manager be impressed with the fact that the best advertisement is a pleased customer, and the best possible solicitor is a consumer who is satisfied. All the work of his department is practically wasted if the new business taken on is not properly cared for.

Good Service—The new-business department must be backed by good service, and "good service" only begins with the production of the current. Good service requires that there should be polite and attentive clerks, collectors, meter readers and trouble men; that complaints shall be listened to and promptly investigated, and the settlement of disputes and adjustment of claims shall not be sidetracked and postponed beyond reason. The very existence of a company depends upon the good will of its customers, and for this reason inattention and discourtesy on the part of any of its employés should be considered unpardonable.

The agents of the new-business department go out after business. They approach a man in his own house or office, and then it is that a man is liable to talk freely of how the company has treated him. If the treatment has been bad, the agent's chances of doing more business are very slim. If the treatment has been good, the chances for more business are excellent. Again, it is pointed out that the best means for advertising a business is to be advertised by its friends. If a man is a consumer, look after him. If he has a complaint or is in trouble, give his case immediate attention. His general opinion may be that corporations have no souls, but he will find that individuals in the corporations have, and it is by the work of the individuals that he is going to judge your particular corporation. If a man is a power user, he is depending on that power to help him earn his daily bread. He may have a large number of employés, or he may be operating a motor by himself. In either case, if the power goes off, or some trouble occurs with his service, he is put to inconvenience and expense until the trouble is rectified. As a rule, when he has trouble with his motor or service, the first thing he does is to call up the electric company. The first thing the electric company should do in such a case is to give this man's trouble the right of way. Whether the cause of the trouble is the fault of the company or the consumer does not much matter; the fact that the consumer is shut down is sufficient reason to see that he may be running again as quickly as possible. It is this kind of treatment that make friends for the company. It will be found that one of the most successful ways of convincing prospective power users that the energy you have to sell is the energy they need, is to take them to plants which are being operated by electric power for similar purposes to what they would use it. Then have these consumers who have been using power for some time tell the prospective customer how electricity works; what are the advantages and troubles (if any) and what is the cost of operation. The prospective customer is liable to think that the agent of the company is prejudiced, and you can not blame them. Besides, the man who is trying to sell him a steam or gasolene plant has probably told him something just the opposite to what your agent has said. But if he is going to run a machine shop, or a planing mill, or a foundry, or a peanut stand, take him or send him to some of your customers who have been running similar plants with your electric power. And if you have treated your customers right, they will honestly help you to win others—and frequently put themselves out of the way to do it.

Results—However, results are the best test of all work, and there is nothing problematical about the results to be obtained by a new-business department if it is operated with diligence, intelligence and perseverence. Let the department manager cultivate among his assistants a spirit of pride in the work. Let him encourage and enthuse them, so that a healthy emulation may exist; an emulation to excel each other for the benefit of the company's business, and to pull together, so that the successes of to-day may be but the stepping stones for the achievements of to-morrow. Let there be politeness, attention and courtesy in all ranks and at all times, and under such conditions the central stations will surely prosper, and the tiny stream of new business which had once to be coaxed and persuaded will eventually begin to flow as a river, and continue to grow in force and volume day by day.

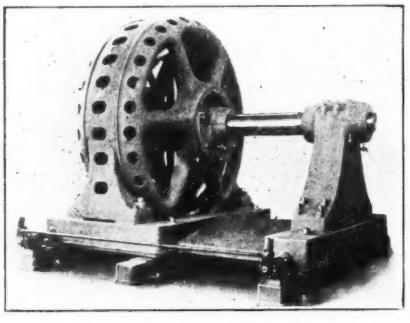
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Large Allis-Chalmers Induction Motors for the Washoe Smelter of the Anaconda Copper Company.

Four large induction motors have been purchased for the equipment of the 10,000-ton concentrators of the Washoe smelter, a new portion of the $9,000,000 reduction plant of the Anaconda Copper Mining Company at Anaconda, Mont. They were designed and built at the electrical works of the Allis-Chalmers Company, Cincinnati, Ohio. This plant is to operate with power supplied by the two stations of the Helena Power Transmission Company, on the Missouri river near Helena, nearly 100 miles from Anaconda. In addition to power being furnished for the smelter and street railway of Anaconda, the improvements now in progress will, when completed, make it possible for the mines of Butte to utilize Missouri river power.

The output of copper from the Washoe smelter, which has been equipped throughout with electrical drive, is from 15,000,000 to 17,000,000 pounds per month. Formerly all the power required was supplied by steam engines, and a certain amount of steam power will probably always be used,

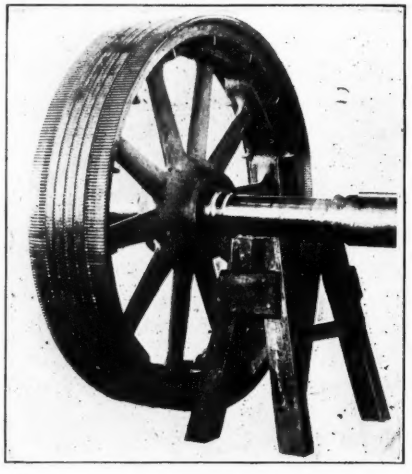


1,200-HORSE-POWER, 360-REVOLUTION, THREE-PHASE, 2,080-VOLT INDUCTION MOTOR.

as some of the steam boilers utilize the heat contained in the waste gases from the furnaces. However, this power, obtained from a by-product, is not nearly sufficient to operate the whole plant, and all additional power in the future is to be supplied by electricity.

A second dam is being built across the river, near Helena, by the Missouri River Power Company, by which the waters will be backed up to form a lake near the capital city. The transmission of power at a pressure of 70,000 volts over a double line to Anaconda, nearly 100 miles distant, involves a pole line and accessory equipment which will be one of the electrical features of the West.

A substation at the smelter contains the step-down transformers for lowering

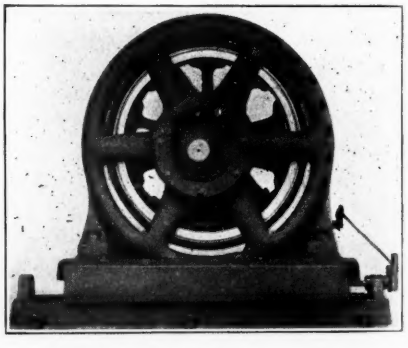


ROTOR OF 1,200-HORSE-POWER INDUCTION MOTOR.

the pressure to 2,200 volts for distribution to the various parts of the plant. The Anaconda company has also recently purchased a water-power plant located at Flint creek about thirty-one miles from the smelter and capable of supplying about 1,500 kilowatts; the power from this plant will be used principally for the operation of blowers and air-compressors in the smelter power-house.

The concentrating plant is the first unit to be driven by electric power exclusively, the four large induction motors being used for this purpose. The concentration building is 600 feet long with the steam plant heretofore used for driving it, located in the centre. The jigs, tables, etc., are driven from a main line shaft, 500 feet long, to which the engines have been connected by rope-driven and friction clutch pulleys. It is intended to leave this steam plant intact, to be used as a reserve in case the electric power fails, and disconnect the shaft at each side where it enters the engine room, thus dividing the shaft into three parts, a live section on each side of the engine room. The mill as a whole is divided into eight sections, four on each side of the engine room. Two induction motors will be installed in each half of the mill, and connected to the main shaft by rope-driven and friction clutch pulleys. Each motor has a 1,200-horse-power output at 360 revolutions per minute synchronous speed, and will furnish power sufficient to operate easily two mill sections; connection is made to the main shaft by eighteen two-inch ropes, and the pulley dimensions are such that the main shaft will be driven at 250 revolutions per minute.

These motors are notable not only on account of their large size, but also because of their having squirrel-cage rotors, something unusual in motors of this size. Their guaranteed full-load efficiency is ninety-one per cent and full-load power-factor, ninety-two per cent. Squirrel-cage motors were chosen for this installation because the conditions under which they have to start are favorable. The motors being connected to friction clutches, start up light and as the mill runs continuously, it is not expected that the motors will be started at all frequently. The power system of the Missouri River Power Company is so large that the occasional starting of one of these motors will not cause undue disturbance, while the higher power-factor under ordinary running conditions is a decided advantage. Tests



1,200-HORSE-POWER, 360-REVOLUTION, SIXTY-CYCLE, THREE-PHASE, 2,080-VOLT INDUCTION MOTOR.

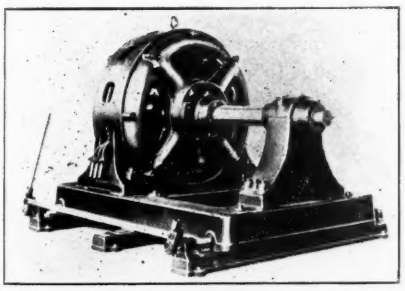
show that those motors exceed the guaranteed power-factor of ninety-two per cent, and that the starting current taken from the line will not exceed full-load running current when starting the motor with its ropes and friction pulley connected.

Starting is effected by an oil-immersed controller connected to an autotransformer which lowers the applied voltage at starting. The controller has six steps, so that the motor can be brought up to speed gradually. Since the motors are arranged in pairs in the mill, one controller is provided for each pair of motors, and the

necessary instruments, switches, etc., are mounted on two two-panel marble switchboards placed near the motors; the controller is operated by means of a hand-wheel on the front of the board.

The main switches and also the transfer switch for connecting either motor to the controller are of the oil-immersed type and interlocked with the controller handle in such manner that it is impossible to close the main switch of either motor while the controller is at the "on" position.

The general construction of these large induction motors is practically the same as that of the smaller ones built by the Allis-Chalmers Company. The stator punchings are supported in a substantial yoke to which the housings carrying the bearings are bolted. The bearings are adjustable to permit compensation for wear, and thus maintain a uniform air-gap between stator and rotor. The stator is wound with copper strip with the slot insulation forced around it under pressure in steam-heated moulds. The end connections of the winding are rigidly supported to prevent any distortion due



200-Horse-Power, 450-Revolution, Sixty-Cycle, 2,080-Volt, Variable-Speed Induction Motor.

to abnormally large current. The rotor is mounted on a spider provided with cast-steel end rings between which the laminations are held. The rotor slots are of the partially closed type and the rotor bars are securely held in place by the overhanging tips of the teeth. The bars are bolted at each end to bronze short circuiting rings, thus making a very strong rotor that can be safely run at high peripheral speed.

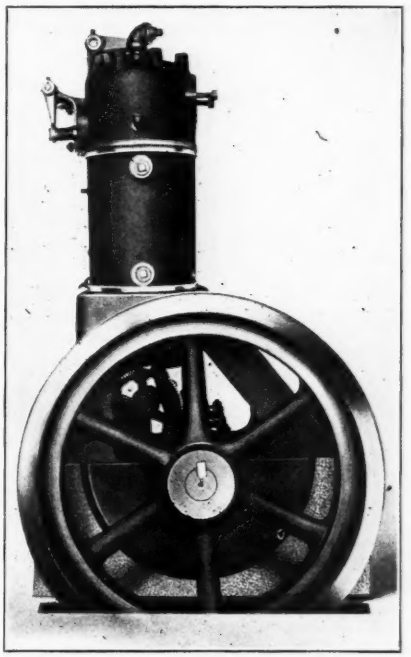
In addition to the four large motors there is also provided a 200-horse-power, variable-speed, sixty-cycle, 2,080-volt induction motor for operating the pumps in the mill. This motor is of the standard type with wound rotor and collector rings for the insertion of resistance in the secondary. The normal speed is 450 revolutions per minute, and can be reduced to 225 revolutions per minute by means of a grid type resistance furnished with the motor. The motor also has adjustable bearings.

For the equipment of the substation the Allis-Chalmers Company has furnished three synchronous motor-generator sets of 300 kilowatt output each, and one small induction motor-generator set for starting and exciting the synchronous sets. The 300-kilowatt sets are driven by twelve-pole, 2,080-volt, sixty-cycle synchronous motors and run at a speed of 600 revolutions per minute. The direct-current generators for these sets are compound-wound for 550 volts, and are able to carry fifty per cent overload for two hours without heating more than fifty-five degrees centigrade and without sparking. At normal full load the temperature rise does not exceed thirty-five degrees centigrade in any part. The sets have three bearings and the stator of the synchronous motor is arranged to slide sideways on the base to give access to the field and armature windings. These units will be used for operating direct-current crane motors throughout the plant and also for furnishing power to the Anaconda street railway. During parts of the day the load will be quite light, and it is intended to operate the synchronous motors with over-excited fields so as to compensate to some extent for the lagging current caused by the induction motors.

The fields of the synchronous motors are excited from a 120-volt, twenty-five-kilowatt, direct-current generator driven by an induction motor. The same motor is also coupled to a small 500-volt direct-current machine which supplies current for starting the sets. This machine has commutating poles, and a large current can be taken from it for short intervals without sparking at the commutator or undue heating in any part of the machine.

A Novel Crank Mechanism for Internal-Combustion Single-Acting Engines.

The accompanying photograph shows the crank mechanism which is now being offered by the Ramsey Engine Company, Bullitt Building, Philadelphia, Pa., to builders of single-acting engines. The chief feature of this device is the placing of the engine cylinder vertically over or horizontally in line with the crank pin when the crank stands at right angles to the axis of the cylinder. This disposition of the cylinder changes the angularity of the connecting rod, so that the thrust comes nearly at right angles to the crank when the internal pressure in the cylinder is greatest; and, moreover, during the power stroke this angularity varies much less than it does in engines in which the main shaft lies in the axis of the cylinder. The advantages of this are the more direct thrust upon the crank pin and less side thrust on the piston; and, at the same time, the arrangement increases somewhat the travel of the piston for a given crank throw when compared with engines of the ordinary type. This increase in the travel of the piston and reduction in angularity, which reduces the frictional losses in the cylinder, are said to increase considerably the efficiency of the engine. Of course, such an arrangement would lose on the return stroke as much as it gains on the



Ramsey Crank Mechanism.

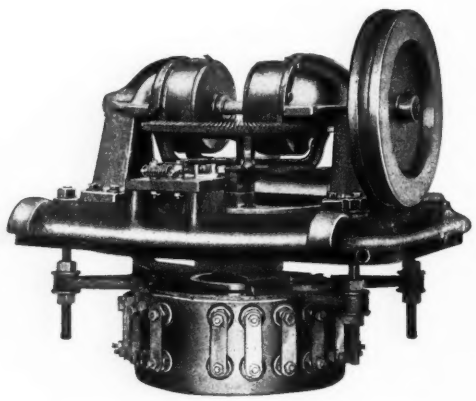
forward stroke in a double-acting engine but when applied to single-acting engines the greater angularity of the connecting rod during the return stroke is not against the high pressure which exists in the cylinder during the power stroke, and there is, in consequence, less side pressure against the cylinder walls. The arrangement is said also to allow of a quicker opening of the exhaust valve and a reduction in the back pressure during the exhaust stroke.

A series of tests was made of an engine constructed in this way, under the supervision of the University of Pennsylvania. This was a gasolene engine of the vertical marine type, having a nine and one-half-inch by fourteen-inch cylinder. This engine, it is said, developed one horse-power with a consumption of from one-tenth to one-eleventh of a gallon of gasolene per hour, when working under loads of from twenty-two to thirty horse-power. The total efficiency of the engine was said to vary from 24.1 to 25.9 per cent. These figures include the thermal efficiency and the mechanical efficiency of the engine.

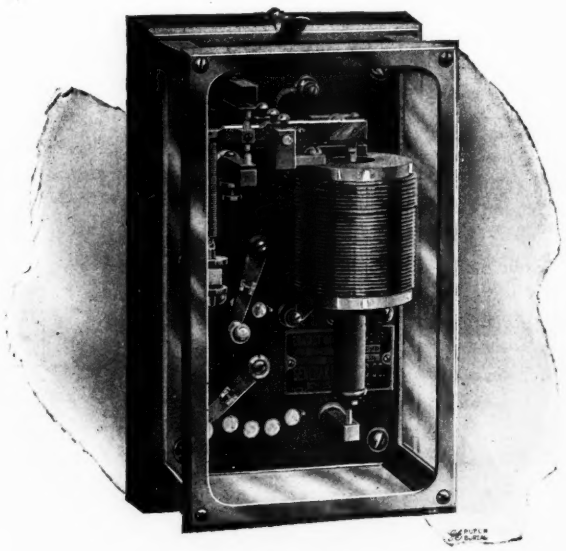
The Ramsey Engine Company does not purpose building engines, but will license manufacturers of internal-combustion engines to utilize this mechanism.

Automatic Feeder Regulators.

Proper voltage regulation of individual feeder circuits for both power and lighting is recognized as an important factor in the economical operation of a power plant. Such regulation may be controlled by the station attendants or automatic methods of regulation may be adopted. For automatic regulation of feeder circuits the General Electric Company, Schenectady, N. Y., manufactures two forms of voltage regulation which are of special interest, known respectively as type BR and type IR. The general principle of operation of both these forms of regulators is similar in that they are in effect variable ratio transformers or compensators having two separate windings. The primary or shunt winding is connected across the line, while the secondary or series winding is connected in series with the line to be controlled. While both forms of regulator boost or lower the voltage by changing the transformer ratio, the methods used in the two cases are quite different.

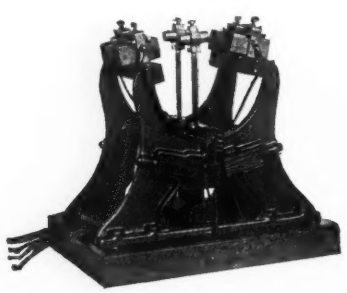


Switching Mechanism of BR Regulator.



Contact-Making Voltmeter.

In the BR type of regulator the windings are assembled on a shell-type core and taps are brought out from the secondary winding to stationary slip rings.

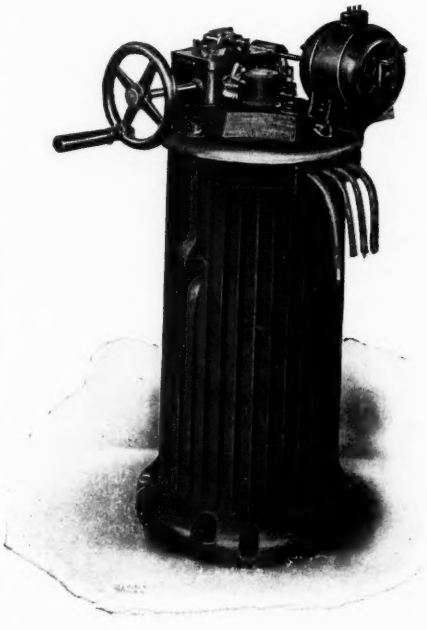


Relay Switch.

The various combinations of turns producing the voltage change are made by the controlling mechanism of the regulator. In the IR type of regulator, on the other hand, the secondary and primary windings are assembled upon separate cylindrical and concentric sheet-iron cores. The series or secondary winding is arranged in slots on the inside circumference of the stationary outer core, and the shunt or primary winding is placed in similar slots on the outside circumference of the movable inner core. The change in the angular position of these cores varies the flux distribution and so produces the boost and lower in the voltage. The coils on both stationary and movable cores are in effect polar windings, and both are similarly wound. With a given pole of the primary opposite a given pole of the secondary, the regulator will boost the line voltage, while, if dissimilar poles are opposite, the voltage will be lowered.

The mechanical arrangements of the regulators are compact and simple. In the BR regulator, in which there is no moving core, the connection changes are made by a rotating switch. The moving member of this switch carries a series of fingers, each of which is connected to a corresponding stationary collector ring by means of a suitable brush, and the ring is connected to the line through a preventative resistance. This resistance allows a small exchange of current between the fingers, and thereby prevents any break in the circuit when passing from one step to another. The switch is operated on a vertical shaft by a bevel gear which in turn is driven by magnetic clutches on the horizontal shaft, the switch rotating in one direction or the other, depending upon which clutch is excited.

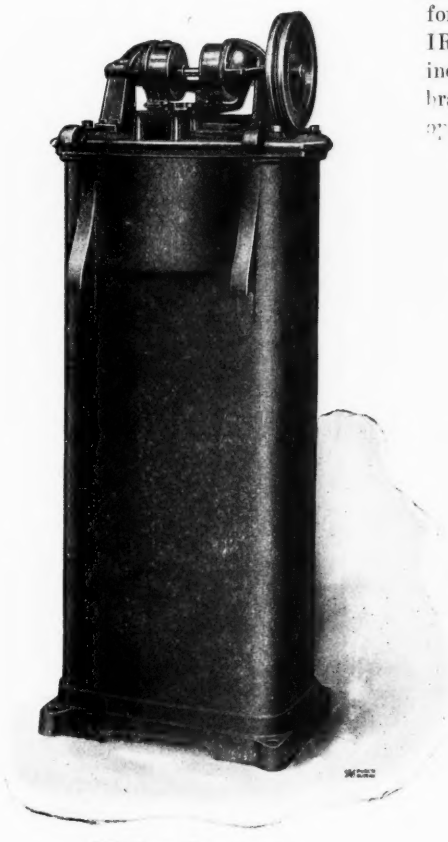
In the IR type of regulator the mechanical arrangement is exceedingly simple. The movable or primary core is mounted on a vertical shaft, the upper end of which carries a worm-gear segment, while the other end rests in a step-bearing. Both primary and secondary windings are brought out by means of flexible cables, with the exception of large regulators for rotary converters, which have the secondary arranged with bus-bar terminals. The entire arrangement is simple and substantial in construction, and, with the exception of the windings, is practically indestructible.



IR Type Regulator.

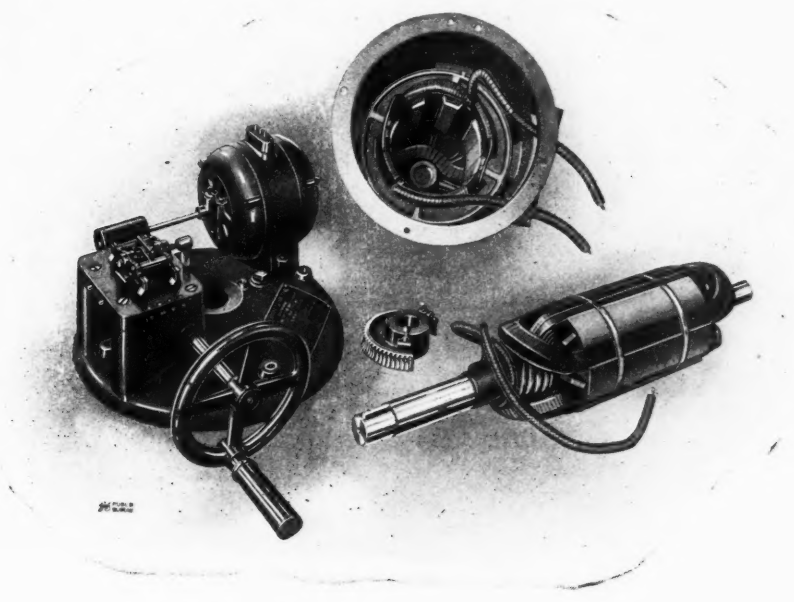
Both types of automatic regulators are operated by polyphase motors, but the method of control is different. In the

IR or movable core regulator the operation is as follows: across the potential transformer, in the feeder line, is placed a contact-making voltmeter, the regulator being in series with the line. As the line voltage rises or falls, the contact-making voltmeter responds, making contact on one of two points respectively. These contacts in turn close the circuits in a relay switch, which starts the polyphase motor. This relay switch operates the motor in either direction, according to the "boost" or "lower" position taken by the contact-making voltmeter. The motor then revolves, adjusting the main circuit voltage by changing the angular position of the cores as described, until the line voltage becomes normal. At that instant the contact-making voltmeter opens, in turn opening the relay switch and the motor circuit.



BR Type Regulator.

In the BR type of regulator, the contact-making voltmeter forms an essential part of the control, but the relay switch is omitted. In this type of machine the driving motor, which may be of any type, revolves continuously, but operates the revolving switch mechanism only when the magnetic clutches on the horizontal shaft are energized. A single motor may operate a number of regulators. The contact-making voltmeter, responding to the rise and fall of the line voltage as in the case of the IR regulator, sends a direct current through one or the other of the clutches. These clutches then rotate the switch by means of the mechanical arrangement of the bevel gear drive as explained. If it is desired to compensate for line drop and maintain a constant potential at some distant point on the feeder, it is only necessary to provide the relay with a compensated winding, connected in series with the line, or through a suitable current transformer. The compensated winding on the relay is arranged with two sets of dials, as shown, so that a very close adjustment can be obtained within the limits for which the device is designed. In the IR regulator, where there is considerable inertia in the moving parts, a magnetic brake operates when the motor circuit is opened, which prevents hunting, but this device is not required on the BR type, since the parts are light and stop when released by the clutches.



Parts of IR Regulator.

Each of these regulators has its individual application according to the operating conditions. The BR regulator is particularly designed for feeder circuits where the fluctuations in voltage are very rapid. Such conditions are imposed when both lamps and induction motors are operated on the same circuit. The rush of current taking place when a large induction motor is thrown on the line makes the lamps flicker unpleasantly unless a quick acting regulator is provided. The BR type of regulator meets these conditions and smooths out the fluctuating voltage curve, as it operates over its full range from lower to boost in six seconds. The IR type, on the other hand, is well adapted for lighting circuits where the load comes on more gradually and such quick regulation is not essential, as, for example, the regular lighting load at a power station which increases rapidly toward nightfall.

While both these types of regulators have very good efficiencies and power-factors, these are of relatively small importance. Take, for example, the IR type of regulator. Feeders seldom require a regulation exceeding twenty per cent, and a regulator having even as low a power-factor as eighty-five per cent does not have any appreciable effect on the line. Such a regulator would have a magnetizing current and a reactance exceeding twenty-five per cent, and assuming that the regulator is arranged for a ten per cent boost and lower, and that the power-factor on the line is 100 per cent, the effect of the regulator having this low power-factor and with full load on the line will only reduce the power-factor on the line 0.2 per cent; in other words, the power-factor would become 99.8 per cent. With a five per cent boost and lower regulation under the same conditions the line power-factor would be 99.9 per cent. It is therefore evident that the reactance in the regulator has a negligible effect on the power-factor of the system as a whole.

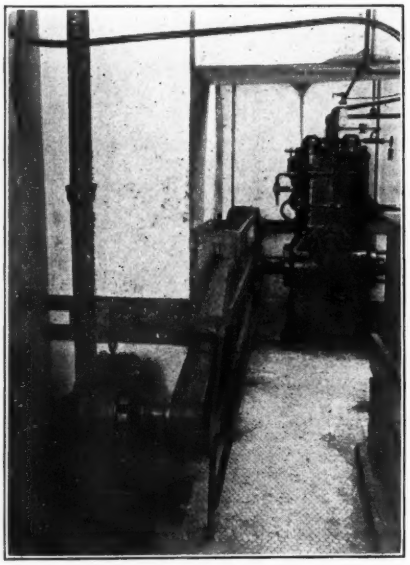
Both types of regulators are built in standard sizes for sixty cycles and 2,200

volts to boost and lower the voltage either five per cent or ten per cent above and below normal. The BR regulator is usually built in sizes from eleven to twenty-two kilowatts, while the IR types for single or polyphase circuits range in size from 5.5 kilowatts to forty-four kilowatts. Their capacity, however, is practically unlimited and has already been extended to 1,200 kilowatts. The General Electric Company is also prepared to furnish automatic regulators of the same general construction as the standard types but wound for special voltages or frequencies.

Electrically Operated Refrigerating Plant in the Gallatin Hotel, Uniontown, Pa.

Mechanical refrigeration employing electric motors as its source of power is covering a very broad field and has almost unlimited application in the preservation of food products and maintaining a low temperature in many industrial processes, as well as in domestic and household use.

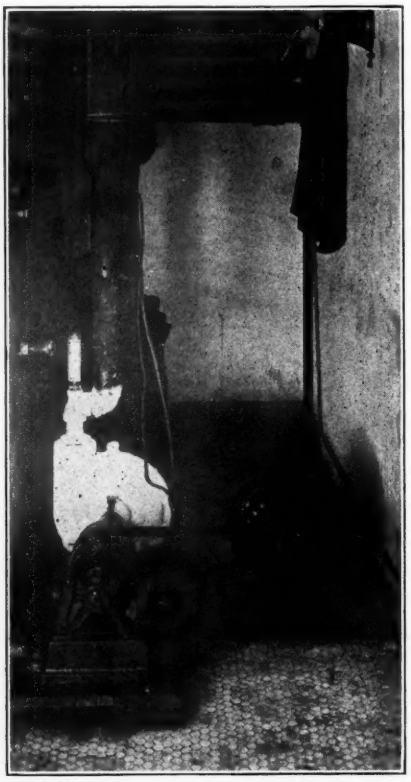
In some cases the adoption of mechanical refrigeration depends greatly upon the question of economy, and in others cost is sacrificed for cleanliness, convenience and easily controllable temperature. Refrigeration is not confined to the cooling of various products, however, but is largely used in furnishing cooler air in private and public buildings during the heated seasons of the year.



Ten-Horse-Power Westinghouse Type CCL Induction Motor Driving Ammonia Pump.

The machines now used to produce a reduction in temperature are nearly all based on the principle of production of cold by the evaporation of liquid to the gaseous form; and of the many systems of ice-making and refrigerating in extensive use to-day, the ammonia compression system occupies a preeminent position. It consists of a complete cycle of operations, involving three successive steps—compression, condensation and expansion. These three steps are made continuous and are constantly repeated.

An illustration of the foregoing is found in the refrigerating plant in the Gallatin Hotel at Uniontown, Pa., views of which are given herewith.



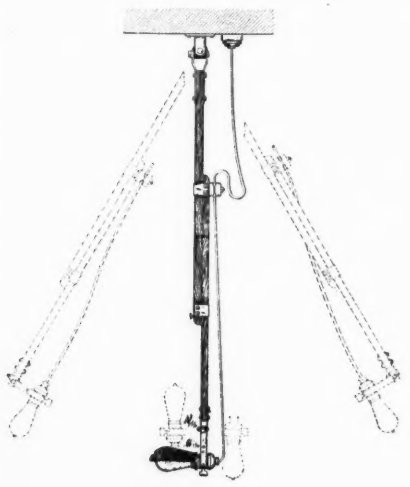
Two-Horse-Power Westinghouse Type CCL Induction Motor Driving Brine Pump.

The ammonia compressor, made by the Brunswick Refrigerating Company, is driven by a ten-horse-power Westinghouse type CCL motor. From the compressor the liquid ammonia is circulated in coils within the brine tank and returns in a gaseous form. The cool brine is used for the double purpose of making ice for table purposes and for cooling the beer cellar and ice-boxes. Ice-cans filled with fresh water are submerged in the brine tank, and the average output of ice is six tons per day.

A circulating pump driven by a Westinghouse two-horse-power, type CCL motor forces the brine to the beer cellar, which is nine feet by sixteen feet by seven and one-half feet, and is maintained at an average temperature of forty degrees Fahrenheit. Besides the beer cellar there are three ice-boxes, each five feet by six feet by seven feet, and one cook's box, four and one-half feet by five feet by seven feet. Two of the ice boxes are used for freezing purposes and are maintained at an average temperature of sixteen degrees Fahrenheit.

The "Universal" Electric Light Holder.

The Gail-Webb Manufacturing Company, 6-8 Lock street, Buffalo, N. Y., has placed upon the market a device for holding an electric lamp, designated as the "Universal" electric light holder. This device allows the light to be swung in a complete circle, raised and lowered at will, and twisted and turned to any conceivable angle. The holders for twelve-foot ceilings have a total length of nine feet, six inches. Their scope is any position within a circle of ten feet in diameter. They have four feet of longitudinal travel. The holder is flexible, having a universal joint at the top and bottom, with a sliding joint between. Automatic friction devices at all joints enable the lamp to be moved into any position and keep the lamp in that position. The slack in the cord is always out of the way. The accompanying illustration shows a few of the applications of this device.



Drop-Light Holder.

Erratum.

The address of the DeLamar Copper Refining Company was given as Perth Amboy, N. J., on page 149 of the issue of the Electrical Review for July 28. This should have been Chrome, N. J.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

SYRACUSE RAILWAYS USE NIAGARA POWER—On the afternoon of July 29 the cars on the Dudley, East Genesee, Grape and Butternut street lines in Syracuse, N. Y., were operated by means of power from the plant of the Niagara, Lockport & Ontario Power Company at Niagara Falls.

CHICAGO TELEPHONE COMPANY—The Chicago Telephone Company has put into effect reductions in charges and made other concessions in the way of improved service. Prices for measured service are reduced so as to make a much lower schedule for ordinary business telephones. Under the new schedule the company sells 600 calls per year for $60, a reduction of twenty-five per cent. For additional calls there is a graded charge of six, five, four and three cents.

MASSACHUSETTS POWER PLANT—The Light, Heat and Power Company, Boston, Mass., of which Arthur E. Childs is president and Addis M. Whitney is treasurer, has purchased the Royal Cheney farm of sixty-three acres at Still River, seven miles from Ayer, Mass., for the purpose of erecting a central power station to furnish light and power for the towns of Leominster, Clinton, Ayer, Harvard and Groton. The purpose of the company is to abolish the present local plants in the towns mentioned and to supply power and light from a central station. The company already controls the Leominster Gas Light Company.

SOUTHERN BELL INCREASES STOCK—The stockholders of the Southern Bell Telephone and Telegraph Company at a recent meeting in Richmond, Va., decided to increase the capital stock of the company from $2,500,000 to $3,000,000. The $500,000 of new stock is for the purpose of paying for new fireproof buildings in Richmond and Norfolk, underground cables and extensions and other improvements. Among the contemplated improvements is said to be the construction of a number of standard long-distance lines for the purpose of connecting Richmond with every town of importance in Virginia. It is expected that this work will be done within a year.

NEW ST. JOSEPH-KANSAS CITY AIR LINE—The St. Joseph & Southern Railway Company has been chartered at Jefferson City, Mo., by John Donovan, John D. Richardson, N. B. Biles, Edward C. Swift, James N. Burns, Henry Krug, Jr., J. C. Schneider and Jesse I. Roberts to build an air line between Kansas City and St. Joseph, Mo. John Donovan, head of the enterprise, is the western representative of the Swift interests in numerous projects, and is president of the St. Joseph Stock Yards Company. The capital stock of the new company is $500,000, and the term of incorporation, 200 years. Motor-cars are to be used on the road to take care of suburban and local passenger traffic.

SAYS CITY OWNERSHIP PAYS—The ninth annual report of the electrical department of the city of Chicago, Ill., gives figures which show apparently that the municipal ownership of street lights has been a financial success. City Electrician William Carroll figures that the cost of rented service since 1888 would aggregate the sum of $5,332,113, to which he adds interest at four per cent, making a total of $6,687,910. The city has expended $4,748,890 for construction and operation of the municipal plant, which, with the interest computed at four per cent, will give a total of $6,212,846. This, Mr. Carroll declares, shows an actual saving in cash to the city of $475,068. From this, however, he deducts $85,784 as lost taxes for the first thirteen years of operation, and an additional loss of $65,474 in taxes for the last five years, leaving a saving to the city of $323,805.

MEXICAN POWER FRANCHISE—A concession has been obtained by Messrs. Norcross & Taylor from the Mexican government to utilize 3,500 litres of water per second from the Salado river or from the Nogales lagoon, in the canton of Orizoba, state of Vera Cruz, for generating electricity. The concession carries authority to establish a transmission line or an underground distribution system and to construct all such hydraulic works and canals as may be necessary for the purpose. Surveys for the location of the works must be commenced within six months. The plans and profiles must be submitted within twelve months, and the construction of the works must be commenced within twenty-four months. The whole installation must be completed within seven years. The franchise includes the free importation of machinery and the construction of telephone and telegraph lines.

MICHIGAN STATE TELEPHONE—The Michigan State Telephone Company is threatened with more rivalry in Detroit. This is due to the formation of the Home Telephone Company, to be financed by the issuance of $3,000,000 six per cent bonds. The bonds have been sold through the Electric Construction Company to the Commonwealth Trust Company, of St. Louis. The promoters are largely St. Louis people with whom are associated the Brailey group of independent telephone promoters. The independent company has been engaged for several weeks in a house-to-house canvass to secure subscribers. Public sentiment, however, seems against a double telephone service, and the new company has obtained only a comparatively small number of subscribers. The Michigan State Telephone Company has nearly 20,000 subscribers' stations in that city alone, and has made arrangements to increase the capacity of the Detroit exchange to 60,000 subscribers' stations. It will spend in Detroit next year over $1,000,000.

WISCONSIN TELEPHONE COMPANY INCREASE—Out of a $10,000,000 increase in the capital stock of the Wisconsin Telephone Company decided on at a recent meeting of the directors of the company, approximately $250,000 will be expended in rebuilding the entire South side district in Milwaukee, and erecting the addition to the South side exchange that is now under way at Hanover and Washington streets. The improvements on the South side include a fine new switchboard to be installed as soon as the new building reaches the requisite stage of completion, and new poles and wires wherever needed, and in fact a general renewal of the whole district. Other improvements to be hurried to completion and paid for out of the $4,500,000 that will become available at once as a result of the action of the directors will be the completion of improvements at Waukesha now under way. A new switchboard is also to be installed at the Spring City. Improvement and extension work at Beloit, Janesville, Port Washington, Neenah, Kaukauna, Sturgeon Bay and many other important points in the state has also been decided on and outlined for prompt attention.

LOW LIGHTING BIDS—The city of Oneida, N. Y., after January 1, 1907, will be one of the cheapest lighted cities in the state. Bids were opened recently showing a considerable difference in the cost of this public utility. The specifications under which the bids were made call for ninety street lamps to burn until one o'clock and forty lights to burn all night. Seventy-five free incandescent lights for municipal buildings, etc., are also required. At present the city of Oneida is paying about $7,000 a year for lighting its streets, etc., or at the rate of about $70 for all-night lights and $55 for one-o'clock lights. The bid of the Empire State Power Company, of Amsterdam, which is low, shows a difference of about one-half in the total yearly cost. This company's bid for extra lights that may be required by the city is $25 for the one-o'clock lights and $37.50 for the all-night lights. The rate per light now paid is about double this figure. The Empire State Power Company is the company which has the contract for furnishing power for the West Shore trolley service, and if this company is awarded the contract the current for lighting Oneida will be switched from the West Shore at Oneida Castle. Under the terms of the contract to be awarded, the successful bidder must give heavy bonds to furnish a light satisfactory in every way to the board of public works.

ELECTRIC RAILWAYS.

OSKALOOSA, IOWA—The contract has been let to the Cooke Construction Company, of Minneapolis, to build the Oskaloosa & Buxton Interurban.

ATHENS, GA.—The Athens Electric Railway Company will increase its capital from $125,000 to $275,000, and make a number of extensive improvements.

BROCKPORT, N. Y.—At a meeting of the Brockport village board the franchise granting the Buffalo, Lockport & Rochester Railway Company a right of way through the village was signed.

PROVIDENCE, R. I.—The North Smithfield town council has granted a franchise to the Worcester & Providence Street Railway Company to construct and operate in the town an electric street railway.

SOUTH BEND, IND.—Arrangements have been made to begin work on the Chicago, Lake Shore & South Bend Railway, which will connect Michigan City, New Carlisle, Gary and Indiana Harbor, Ind., and Chicago.

TAYLOR, TEX.—J. A. Thompson, chairman of the executive committee of the proposed Taylor & Houston Railroad, has closed a contract with F. L. Dormant, of Houston, for a preliminary survey of the road.

CINCINNATI, OHIO—A movement has been started for the organization of a company to build an electric traction road from Rose Hill, in Avondale, north through Sharon, to Middletown and Franklin, a distance of about forty miles.

RAVENNA, OHIO—Thomas Childs, of Akron, is behind a plan to build an electric railroad from Ravenna to Garrettsville, a distance of twelve miles. Mr. Childs is the man who promoted the Canton-Akron line and the New Philadelphia line.

MAYSVILLE, KY.—At a meeting of the stockholders of the Maysville, Carlisle & Millersburg traction road it was decided to commence work immediately. Eastern capitalists will furnish the money. The cost of the road will amount to about $1,000,000.

IOWA CITY, IOWA—The people of Holbrook and vicinity are eager for the building of the proposed Iowa City, Montezuma & Des Moines Railway. They have agreed to subscribe $30,000 in cash and right of way for the six miles of territory in which they are particularly interested.

SEATTLE, WASH.—It is announced that the Portland & Seattle Railroad Company, a subsidiary corporation of the Northern Pacific and Great Northern roads which has acquired the old Union Pacific right of way, will operate the line between Seattle and Portland with electric power.

INDIANA, PA.—The Indiana town council has granted a franchise to the Indiana Street Railway Company for a right of way through Fifth and Sixth streets. This company was formed by the merging of the Indiana & Blairsville, Indiana, Clymer & Creekside and the Indiana Railways companies.

BARBERTON, OHIO—The name of the Barberton, Wadsworth & Western electric railway has been changed to the Akron, Wadsworth & Western. Work on the Wadsworth line is progressing rapidly, and the right of way has now been secured, so that the work can go on without interruption.

HARTFORD, CT.—The Consolidated Railway Company has decided to use the steam tracks of the Norwich & Worcester division for trolley purposes between Taftville and Central Village. Trolley wires will be strung over the tracks as far as Taftville, where the cars will be diverted to the Norwich trolley system.

NEW HAVEN, CT.—President C. S. Mellen, of the New York, New Haven & Hartford Railroad, has issued orders to electrify the line from Middletown to Berlin and from Middletown to Meriden, to be operated as a trolley. The construction department of the company is already preparing material for the work.

MANITOWOC, WIS.—Actual work on the new Fox river electric line from Manitowoc to Sheboygan has been started at Cleveland station, and officers of the road state that it will be finished by March 1, 1907. The line is twenty-five miles long, and is the connecting link between Manitowoc and Milwaukee. The company will carry both passengers and freight and will operate on a one-hour schedule.

LIMA, OHIO—A special meeting of the Western Ohio railway stockholders will be held at the company's office in Lima on August 15 to vote on a proposition for increasing the capital stock of the company from its present figure, $3,000,000, to $3,400,000. The increase of $400,000 is to be six per cent cumulative preferred stock.

NORRISTOWN, PA.—The Montgomery Rapid Transit Company has awarded contracts for the building of its twenty miles of new line between Souderton and Trappe as follows: grading, to Walter Derr, Norristown; masonry for bridges, to James M. Smith, Schwenksville; steel superstructure for bridges, to the Pennsylvania Steel Company.

OLEAN, N. Y.—The Rock City Railroad Company, of Olean, a reorganization of the Olean, Rock City & Bradford Railroad Company, running between Olean, N. Y., and Bradford, Pa., a distance of twenty miles, has been incorporated with a capital of $100,000. Among the directors are Charles V. Nellany, Oscar F. Corgi and Albert M. Hartung, of Buffalo.

DES MOINES, IOWA—The Des Moines City Railway Company is preparing to build a new central power-house to cost $200,000. It will be run in addition to the present plant, and the current will be used for power on a number of proposed city extensions and interurban lines, as well as for supplying additional power needed for operating the present mileage.

DAYTON, OHIO—An important franchise has been granted to the Cincinnati, Dayton & Toledo Traction Company, a Schoepf syndicate line, by which the company will build double tracks north and south of Dayton on the Salem and Cincinnati pikes, respectively. It is proposed also to extend the service, and, according to plans, a new line will be built from Dayton View to Oakwood, the northern and southern suburbs.

ST. PAUL, MINN.—With the avowed purpose of constructing an electric line from Anoka to Minneapolis *via* Osseo and Robbinsdale, A. B. Robbins, of Minneapolis, has applied to the city council of Anoka for a franchise to use the streets of that city for tracks, poles and wires and for such concessions as the city may be willing to grant his company. Mr. Robbins is president of the North Minneapolis Street Railway Company.

BROOKLYN, N. Y.—The Brooklyn Rapid Transit Company has begun the operation of the new Canarsie line, connecting Canarsie with Williamsburg, a distance of about six miles. From Broadway ferries to East New York the trains run on the elevated structure and thence on the surface. Ten-minute headway between trains is maintained in the day and half an hour at night. The running time between the two points is thirty-five minutes.

KALAMAZOO, MICH.—A franchise has been granted to the Kalamazoo, Gull Lake & Northern Electric Railroad by the Kalamazoo city council. The road is to extend to Grand Rapids *via* Gull Lake and the Barry county lake district and to Battle Creek. The franchise provides for an interurban loop around the business section of the city, to be used in common by all interurban roads, and also provides for remuneration to the city of one-half cent per passenger.

CLEVELAND, OHIO—The Municipal Traction Company has perfected its organization and taken over the property of the Forest City Railway Company. A. B. Du Pont was elected president of the Municipal Traction Company; Frederic C. Howe, vice-president; W. B. Colver, secretary, and Edward Wiebenson, treasurer. Mr. Du Pont was selected as the general manager and F. C. Alber, who was general manager of the Forest City Company, was made his assistant.

YOUNGSTOWN, PA.—J. G. White & Company, of New York, have been engaged as engineers for the electrification of the steam railroad between Youngstown and Columbiana, Ohio. This road was built by the White company several years ago. The Youngstown & Southern, as the road has recently been named, is now engaged in extending this line to Leetonia, and this extension will be electrified by the White company. The contract covers the necessary rolling

stock, transmission, substations, etc. This line will provide through electric service from East Liverpool to Youngstown and from Canton, Akron, Alliance and Salem to Youngstown. J. G. White & Company will actively push this work, and expect to have it completed this summer.

RUTLAND, VT.—The interests who purchased the Rutland Railway and Gas Company and the Chittendon Power Company, and who consolidated these companies into the Rutland Railway and Power Company, have purchased the Rutland City Electric Company, which is also to be included in the consolidation. Tracy Rogers has been elected president, and Leo H. Wise, vice-president, of the electric light company. This consolidation will now include all the public service corporations of Rutland.

BUCYRUS, OHIO—Work has been begun on the Bucyrus, Marion & Columbus Electric Railway, which will connect Bucyrus with Marion, and will operate with and over the Columbus, Delaware & Marion line from Marion to Columbus. The Bucyrus-Marion line is virtually an extension of the line already in operation from Columbus to Marion. From Bucyrus the line will make connection for Toledo with the Toledo & Columbus Railway Company, and for Cleveland with the Bucyrus, New Washington & Plymouth line.

AVON, N. Y.—The work of electrifying the Mount Morris branch of the Erie Railroad has been commenced, with Avon as the distributing point. Several carloads of materials have arrived and surveyors are at work driving stakes where the poles to support the wires will be erected. An extra gravel-train crew has been put on for the purpose of reballasting the roadbed between Avon and Mount Morris, and the work is well under way. The Erie officials claim that they will have electric cars running on an hour schedule by October 1.

SPOKANE, WASH.—Articles of incorporation have been filed by the West Coast Traction Company. The capital stock is to be $750,000, and the incorporators are: C. H. Weeks, of Spokane; B. J. Weeks, of Tacoma; D. D. Leverson, of London, England; Cyrus Bradley, of Spokane; J. W. Reynolds, of Chehalis; F. B. Hubbard, of Centralia, and W. W. Cannon, of Centralia. The company is formed for the purpose of constructing and operating steam and electric railway lines in Chehalis and Centralia, with a line running to Olympia.

ALLENTOWN, PA.—In connection with its new system of transmitting power from the power station on Front street, the Lehigh Valley Transit Company will erect eight substations. The power plant is expected to be put in use by the middle of September. The substations will be put up at Schnecksville, Slatington, Catasauqua, Hecktown, Coopersburg, Sellersville, Lansdale and Ambler. The contract for four has been let. G. H. Hardner will erect those at Coopersburg and Hecktown and M. T. J. Ochs those at Catasauqua and Schnecksville.

HANOVER, PA.—Announcement has been made that a trolley line will soon be built from York to Gettysburg *via* Hanover. The local line will be continued from the McSherrytown terminus through Edge Grove, Centennial and Bonneauville to Gettysburg. When the line is completed to Gettysburg and the recently surveyed line from York to Hanover is finished there will be a continuous roadway from Philadelphia to Gettysburg. The distance of 150 miles will have only one break, that being at the Susquehanna river, where a ferry will be used.

EASTON, PA.—A mortgage for $500,000 given by the Easton & South Bethlehem Transit Company to the Girard Trust Company, of Philadelphia, to secure bonds, has been filed in Northampton county. The new trolley company is controlled by the capitalists who own the Easton Transit Company, and will be operated in conjunction with the latter's lines in this section. The new route is by way of Freemansburg, and will pass through the territory on which the Bethlehem Steel Company will erect its new buildings and establish its additional plants.

PHILADELPHIA, PA.—Articles of consolidation have been filed at the state department in Harrisburg between the Philadelphia, Morton & Swarthmore Street Railway Company and the Media, Middletown, Aston & Chester Street Railway Company, to be known as the Darby, Media & Chester Street Railway Company. The capital is $600,000. These two companies recently leased their properties to the Philadelphia Rapid Transit Company for a period of 999 years. The rapid transit company is operating the lines in connection with its Darby division.

DETROIT, MICH.—The American Trackless Trolley Company, of Boston, will make application, it is said, to the council at an early date for a thirty-year franchise on a three-cent-fare basis. The company will propose using practically the same route as that specified in the pending People's Railway Company's franchise. The Detroit United Railway is said also to be about to apply for permission to extend its tracks under its present franchises, embodying six-for-a-quarter tickets on all five-cent lines, universal transfers, and an extension of the workingmen's ticket time.

CUMBERLAND, MD.—The Pennsylvania & Maryland Street Railway Company has been granted a charter to construct and operate a line thirty miles long through the Meyersdale region. The capital stock is $200,000 and the road is to run from Somerset to the following places: Berlin, Brothers Valley, Garrett, Meyersdale, Salisbury, Jennings and Frostburg. The officers and directors are C. H. Jennings, Garrett county, president; George W. Kipp, Congressman M. E. Lilly, Towanda, Pa.; D. H. Clark, Punxsutawney, Pa.; H. H. Maust, John N. Wright and J. L. Barchus, Elk Lick.

CHESTER, PA.—A notice has been issued calling for a special meeting of the stockholders of the Darby, Media & Chester Street Railroad Company, to be held at the offices at Folsom, on September 10, 1906. The above name is that adopted at a recent meeting of the Philadelphia, Morton & Swarthmore and Media, Middletown, Aston & Chester Electric Railway companies, called for the purpose of combining the two chartered companies. The stockholders at the coming September meeting will be called upon to decide the question of increasing the capital stock of the concern from $850,000 to $1,500,000.

EUGENE, ORE.—The Eugene city council at a meeting passed an ordinance granting to the Willamette Valley company a franchise for the construction of an electric street railway in Eugene. The franchise has a life of thirty years, and provides that construction work shall begin within six months from the time the franchise is accepted. The company is to build an electric line from Eugene to Springfield, to be completed within eighteen months. A bond of $500 is required, and after the city's population reaches 15,000 one per cent of the gross earnings of the system within the city limits shall be paid to it.

DOLGEVILLE, N. Y.—A trolley franchise was granted to the Little Falls & Canada Lakes Railway Company at a meeting of the Dolgeville village board. The franchise is for ninety-nine years, and after the first ten years the company will be required to pay three per cent of its gross earnings to the village. A bond of $5,000 will be posted to insure a faithful observance of the provisions of the franchise. It is stated in the franchise that work on the road must be started by June 1, 1907, that half the trackage here must be down by December 1 of the same year, and that cars between Dolgeville and Little Falls must run at least once every two hours by July 1, 1908.

CLEVELAND, OHIO—The bondholders' committee of the Springfield & Xenia Traction Company held a meeting recently and decided upon plans for the reorganizing of the company. The committee is composed of J. M. Hutton, of Cincinnati, W. H. Lamprecht and W. S. Hayden, of Cleveland. The following statement concerning the plans decided upon was issued after the meeting: "It is proposed to make a reorganization, effective about October 1, 1906, in accordance with a plan such that the new company will issue $300,000 five per cent preferred stock and $300,000 common stock; the preferred stock to be convertible par for par in first mortgage fives if and when the net earnings of the property reach $20,000 per annum. All of the new securities will be distributed pro rata among the holders of the certificates of deposit which were given for Springfield & Xenia Traction Company bonds. Certain claims against the original company are yet to be disposed of and the carrying out of the committee's plans is more or less dependent upon the results of negotiation with the holders of the claims referred to."

TELEPHONE AND TELEGRAPH.

NEW MARKET, IOWA—The Farmers' Mutual Telephone Company has placed in operation a new switchboard.

SKIATOOK, I. T.—A new telephone exchange is being installed at Skiatook under the management of T. F. McVay.

HARTFORD, CT.—The Southern New England Telephone Company will lay 75,000 feet of duct in Hartford during the current season.

CHICAGO, ILL.—The telegraph lines of the Rock Island-St. Louis & San Francisco system are being reconstructed at a cost of $500,000.

ALBANY, N. Y.—A certificate filed at the secretary of state's office certifies the merger of the Elba Telephone Company with the Bell Telephone Company, of Buffalo.

MONTREAL, QUEBEC—The Canadian Pacific Railway Company has authorized the construction of 7,000 miles of new telegraph lines, a large part of which will use heavy copper wire.

RUTLAND, VT.—The New England Telephone and Telegraph Company has leased a suite of rooms in the Mead Building, now being erected, and will install a new $28,000 switchboard.

KENNET, CAL.—The private telephone line owned by the Golinsky company, and operating eight miles of line between Kennet and the Balakala mine, is to have a four-mile branch to the town of Coram.

CLEVELAND, OHIO—The Cuyahoga Telephone Company will erect a new exchange building at Collinwood. The plans have been prepared by Architects Searles, Hirsh & Gavin, and the general contract has been awarded to the Samuel Austin & Son Company.

HOWARD, KAS.—It is announced that J. H. Close has sold his telephone system in Howard and at Severy, and his toll line between the two towns, to the O. B. Walker Telephone Company, of Howard, which has recently built a new plant and which is at work on one at Severy.

HADDONFIELD, N. J.—John T. Windrim, architect, has awarded a contract to J. S. Cornell & Son for the erection of a new telephone exchange at Haddonfield for the Bell Telephone Company. The building will be two stories high, and will measure twenty-eight by forty-two feet. The cost will be $40,000.

SYRACUSE, N. Y.—The Central New York Telephone and Telegraph Company has awarded to D. C. Weeks & Son, of New York, the contract for its new building in Montgomery street adjoining its present building. It will have a frontage of thirty-three feet and a depth of 125 feet, and will be five stories high.

SALT LAKE CITY, UTAH—The Rocky Mountain Bell Telephone Company has completed the construction of its line from Twin Falls, Ida., to Filer and Buhl, a distance of twenty miles. This line within a year will be carried on through to Boise, giving the company a much shorter route from the Idaho capital to southern points.

WOONSOCKET, R. I.—The Providence Telephone Company is planning to put the greater portion of its wires in the second ward of Woonsocket under ground, and has also obtained telephone rights and installed additional instruments in Blackstone, Millville and East Blackstone, including these sections within the limits of the local exchange.

EAU CLAIRE, WIS.—The Wisconsin Telephone Company is to expend between $50,000 and $60,000 in Eau Claire during the period of three or four months in improvement—consisting of cable and additional central office facilities. The plans and specifications have been completed, and the work will begin as soon as the necessary material to start it arrives.

SYRACUSE, N. Y.—A certificate filed with the secretary of state at Albany shows a merger of the Central New York Telephone and Telegraph Company, the St. Lawrence Telephone Company, the Oneonta Telephone Company, the Milford Telephone Company and the Madrid Telephone Company, under the title of the Central New York Telephone and Telegraph Company.

ANGLETON, TEX.—The Southwestern Telegraph and Telephone Company has begun work putting in a telephone exchange at Angleton. An entirely new long-distance line is being built from Houston down the Columbia Tap Railroad to Columbia and thence to Brazoria, with a branch line from Anchor Junction through Angleton to Velasco. With the new long-distance line and the local exchange in Angleton the telephone service will be greatly improved.

RACINE, WIS.—It is announced that the Union Grove Telephone Company has been reorganized and incorporated with a capital stock of $5,000. The system is to connect with adjacent towns, covering fifteen miles north and south and six miles east and west. Further announcement has been made that a deal has been closed with the Wisconsin Telephone Company to connect the Union Grove and farmers' lines with the Wisconsin Telephone Company's wires, thus giving them long-distance service.

CANANDAIGUA, N. Y.—The Seneca-Gorham Independent Telephone Company at its annual meeting elected the following directors: Thomas B. Wilson, of Halls; William Pulver, of Gorham; A. D. Allen, of Gorham; Duncan S. Allen, of Seneca; Edwin E. Hall, of Stanley; Rice Macauley, of Stanley; John A. Driscoll, of Rochester. Mr. Driscoll was elected president for the third term. Duncan S. Allen, vice-president; Rice Macauley, secretary and general manager; William Pulver, treasurer. The executive committee is composed of Messrs. Wilson, A. D. Allen and E. E. Hall. The treasurer's report showed a prosperous year.

PERSONAL MENTION.

MR. J. P. GILBERT, of Niles, Ohio, who is prominently known in connection with the incandescent lamp industry, is spending the summer with his family at Hull, Mass.

MR. C. O. BAKER, who now has charge of the sale of the Sawyer-Man incandescent lamp manufactured by the Westinghouse Electric and Manufacturing Company in Ohio and the Middle States, has his offices in the New England Building, Cleveland.

MR. HENRY A. CLEVERLY, for years associated with the Cleverly Electric Company, at Philadelphia, Pa., and lately with the Baldwin Locomotive Works, of the same city, has suffered a sad bereavement in the loss of his wife, Sarah Irene, daughter of James C. and Sarah (Holbrook) Gardener, on June 23. Mr. and Mrs. Cleverly were married July 25, 1871.

MR. JOHN A. BUGGY, who for several years has been chief engineer of the plant of the Delaware County Line and the Citizens' Electric Heat, Light and Power Company, Chester, Pa., the interests of which have been purchased by the Philadelphia Suburban Electric Company, has been appointed superintendent of the Delaware County Line, to succeed Arthur G. Jack, who will take charge of the Chester traction lines.

NEW PUBLICATIONS.

REPORT OF THE COMMISSIONER OF EDUCATION—Vol. i of the report of the commissioner of education, Washington, D. C., for the year ending July 30, 1904, is being distributed. This volume is replete with interesting and instructive literature concerning this important branch of the work of the Department of the Interior.

THE MURGAS SYSTEM OF RAPID WIRELESS TELEGRAPHY—The Universal Aether Telegraph Company, Philadelphia, Pa., has published a descriptive treatise relating to the Murgas system of rapid wireless telegraphy, invented and perfected by Joseph Murgas, Wilkesbarre, Pa. The system is carefully described and the text is illustrated by a series of fine half-tones.

WASTE OF WATER IN NEW YORK AND ITS REDUCTION BY METERS AND INSPECTION—The Merchants' Association of New York has issued a valuable volume including a report by James H. Fuertes, C. E., to the committee on water supply of the Merchants' Association, on "Waste of Water in New York and its Reduction by Meters and Inspection." There is also a digest of laws governing the use of water meters in New York by Alfred L. Marilley, and a summary of present conditions relating to the water supply of New York, by J. Hampden Dougherty.

NEW INCORPORATIONS.

ALBANY, N. Y.—Elmira & Seneca Lake Traction Company. $200,000.

LOCKPORT, N. Y.—The Undercurrent Traction Company, of Lockport. $100,000.

DOVER, DEL.—Chester Electric Company. To deal in electricity for heating, lighting, etc. $300,000.

DENVER, COL.—The Iri County Electric Company. $50,000. Incorporators: William C. Barker, William F. Crossley, L. C. Duncan.

NEWARK, N. J.—Newark Block Lighting Company. $100,000. Incorporators: James M. Seymour, Jr., David Seymour and Thomas Thompson.

TRENTON, N. J.—The Stover Telephone Company, Frenchtown. $10,000. Incorporators; John J, Stover, Carrie C. Stover, Matilda C. Stover, Samuel Eddy, Josiah C. Butler.

COLUMBUS, OHIO—Ruggles Telephone Company, Ruggles. $2,000. Incorporators: F. A. Hamilton, H. H. Sutherland, Byron J. Ferris, W. C. Sturtevant and O. A. Quinn.

ALBANY, N. Y.—Berkshire Home Telephone Company, Berkshire. To operate in Tioga and Cortland counties. $5,000. Directors: C. Royce, G. Brown and E. F. Lynch, of Berkshire.

ALBANY, N. Y.—The Cross Island Traction Company. To operate forty-two miles of road, Brookhaven to West Sayville. $500,000. Directors: William M. Moyer, Leroy Baldwin and Paul T. Brady.

PORTLAND, ME.—Buxton & Hollis Power Company. To carry on the business of manufacturing, selling and supplying electricity for light, heat and power in the towns of Buxton, Hollis, Limington and Standish. $1,000.

SAN FRANCISCO, CAL.—Coast County Light and Power Company. $1,500,000. Incorporators: Leo H. Susman, Henry Molloch, L. W. Prior, Walter T. McLean, Henry Bostwick, William B. Bosley and Raymond A. Morton.

HARRISBURG, PA.—Wheatland Street Railway Company, of Wheatland, Mercer county; to build a line one mile long through the streets of Wheatland; $6,000. Greensburg & Latrobe Street Railway Company; to construct a line ten miles long from Latrobe to Greensburg; $60,000.

CHICAGO, ILL.—Effingham & Olney Interurban Railroad. To be constructed from Effingham southeasterly through counties of Clay and Richmond to Olney. Principal office at Eberle, Ill. $2,500. Incorporators and first board of directors: R. S. Wishard, D. Wishard, G. M. Merry, Henry Richards, of Eberle, Ill., and Theron Gould, of Bible Grove, Ill.

SPRINGFIELD, ILL.—Carthage & Western Illinois Electric Railway Company, with principal office located at Chicago. To construct a line from Carthage, Hancock county, to points in the counties of Fulton, Cass and Adams. $2,500. Incorporators and first board of directors: W. M. R. Vose and F. P. Vose, both of Evanston; C. C. Breuer, Ralph A. Griffen and George A. Griffen, all of Chicago.

ELECTRICAL SECURITIES.

The first three days of August realized each a "million share day" in comparison to only two such days for the whole month of July. Sentiment continues bullishly inclined, and under the impetus given the market by the declaration of the dividend in United States Steel common the market advanced rather solidly, practically all of the leading stocks making rallies of from five to twenty points. An encouraging feature has been the publication of a large number of very favorable railroad earnings. One compilation of the reports so far made for the recently ended fiscal year shows a total gross increase of 11.68 per cent, while net increased 24.30 per cent. For the first six months this year the Pennsylvania Railroad system reported a gross gain of $13,521,000, while net increased $6,381,000. The Illinois Central's fiscal year showed a gross increase of $2,127,000, and net increased $801,000. Atchison in the fiscal year made a gross gain of $9,688,000, while net increased $6,564,000. The combined Rock Island-Frisco system for the fiscal year made a gross increase of $10,799,000, and net increased $4,574,000. Southern Railway for the same period made a gross gain of $5,496,000, and in net of $805,000, and Canadian Pacific made a net gain of $7,498,000.

ELECTRICAL SECURITIES FOR THE WEEK ENDING AUGUST 4.

New York:	*Closing.*
Allis-Chalmers common	17½
Allis-Chalmers preferred	49
Brooklyn Rapid Transit	80⅜
Consolidated Gas	137⅛
General Electric	168½
Interborough-Metropolitan common	38¼
Interborough-Metropolitan preferred	77½
Kings County Electric	160
Mackay Companies (Postal Telegraph and Cables) common	74½
Mackay Companies (Postal Telegraph and Cables) preferred	72¾
Manhattan Elevated	147⅜
Metropolitan Street Railway	107½
New York & New Jersey Telephone	127½
Western Union	91⅝
Westinghouse Manufacturing Company	151

The rapid advance in Brooklyn Rapid Transit has attracted considerable attention, and if the report is true that a considerable effort has been made to bear the stock the shorts must have suffered financially. Notwithstanding the fact that approximately four out of every five days during July witnessed rain, earnings of the Brooklyn Rapid Transit system increased on an average $2,000 per day, or about $60,000 for the month. This increase in traffic through the borough of Brooklyn in July was above a $250,000 gain made in July, 1905, and evidences greater general traveling.

Boston:	*Closing.*
American Telephone and Telegraph	133½
Edison Electric Illuminating	235
Massachusetts Electric	69½
New England Telephone	131¾
Western Telephone and Telegraph preferred	90

Massachusetts Electric and Western Telephone made substantial gains with the other stocks irregular.

Philadelphia:	*Closing.*
Electric Company of America	11¼
Electric Storage Battery common	70
Electric Storage Battery preferred	70
Philadelphia Electric	7 15-16
Philadelphia Rapid Transit	30¼
United Gas Improvement	84½

The gross earnings of the Philadelphia Rapid Transit Company for July will show an increase over last year of approximately $80,000. The last few days are estimated, but the amount mentioned is a director's view. The earnings for the year will show an increase in gross of close to $1,250,000. United Gas Improvement was in the eyes of the speculator, considerable movement taking place. The stock was off several points during the week, but closed with a net gain of one-half point.

Chicago:	*Closing.*
Chicago Telephone	126
Chicago Edison Light	135
Metropolitan Elevated preferred	66½
National Carbon common	81¾
National Carbon preferred	120
Union Traction common	4
Union Traction preferred	14

The Metropolitan Elevated carried 123,370 passengers daily during July, an increase of 9,792 per day.

South Side Elevated stockholders are asking $120 for their stock in the new holding company's first preferred 5 per cent stock. One hundred and fifteen has been bid.

Negotiations to complete the merger with Metropolitan Elevated left out are expected to be resumed next week.

ELECTRIC LIGHTING.

MARQUETTE, MICH.—A second municipal electric plant is to be erected at a cost of $60,000.

McEWEN, TENN.—L. D. Baker will at once commence the erection of an electric light plant for McEwen.

FREDONIA, N. Y.—At a special election the taxpayers voted to expend $12,000 to extend the electric lighting plant.

PULASKI, N. Y.—The Pulaski Electric Light and Power Company's dam in the Salmon river at Pulaski has been rebuilt.

MANITOU, COL.—Colorado Springs capital this summer will erect a 300,000-horse-power electric power plant at Manitou.

HUMBOLDT, KAN.—An electric lighting franchise has been granted to V. G. Shinkle. The plant will be installed at once.

NORTH ATTLEBORO, MASS.—North Attleboro's municipal electric light system is to be enlarged at an expense of $35,000.

PAW PAW, MICH.—Paw Paw has voted to issue bonds to the amount of $50,000 for improving the electric light and water plants.

LEHIGH, I. T.—The Twin City Electric Light Company has placed its plant in operation and is now lighting the streets of Lehigh.

EMINENCE, KY.—The Eminence electric light plant has been sold at auction, under order of the circuit court, to T. D. Cole. The price was $4,000.

LANSING, MICH.—Receipts of the Lansing municipal water and electric light system above operating expenses for the past fiscal year were $51,869.

EL RENO, OKLA.—The El Reno Electric Light and Power Company will expend from $30,000 to $40,000 in extending its service to all parts of the city.

LE ROY, N. Y.—The Le Roy board of aldermen has granted the Genesee County Electric Light, Power and Gas Company a permit to extend its line into Le Roy.

LITTLE FALLS, N. Y.—At a meeting of the Little Falls common council the Hudson River Electric Power Company was granted a franchise by a unanimous vote.

OTTAWA, KAN.—Contracts have been closed by the city of Ottawa for the remodeling and renewing of the water and light plants. The amount of the contracts is $48,931.

YOUNGSTOWN, OHIO—The Youngstown Consolidated Gas and Electric Company has secured a building permit for the erection of a $10,000 power plant adjoining its present plant.

KINGWOOD, W. VA.—The electric lighting plant of Kingwood was recently destroyed by fire. The citizens will vote on a proposition to bond the town for the establishment of a new plant.

WATERFORD, N. Y.—Waterford has signed a contract with the Beacon Electric Company for furnishing forty or more arc lights to the village at $94.90 per light per year for a term of five years.

CUMBERLAND, MD.—The Edison Electric Illuminating Company is remodeling and improving its plant, installing additional machinery so as to increase the capacity of the plant to 1,000 kilowatts.

ERIE, PA.—The Union City borough council has accepted the bid of the Union City Electric Light Company, to light the streets of the borough for a term of five years at practically the old contract price.

IDAHO FALLS, IDA.—By a vote of four to one the taxpayers of Idaho Falls decided to issue bonds to the amount of $47,000 for the purpose of building a municipal electric light plant and a city water plant.

FREMONT, OHIO—The Logan Gas Company, operating the Fremont Electric Light Company, and owning the street-lighting franchise, has sold the lighting plant to the Fremont Yarian Company for $35,000.

MEMPHIS, TENN.—Work has been commenced on the powerhouse of the Electric Light and Power Company, financed by the Laclede Gas Light Company, of St. Louis. The new company is capitalized at $1,000,000.

BOSTON, MASS.—A reduction in its charges for electricity to non-contract customers of from eight to seventeen and one-half per cent, according to the hours of burning, is announced by the Edison Electric Illuminating Company.

KENOSHA, WIS.—The city of Kenosha is having plans prepared by the Milwaukee Engineering Company for a municipal lighting plant of 300 to 400 arc light capacity, to be installed before the present contract for lighting the streets expires.

GRAND FORKS, N. D.—Ed Nealy, of Red Lake Falls, Minn., who recently secured the franchise for supplying light and power at Grand Forks and East Grand Forks, states that work will begin at once. There is a dam at Red Lake Falls with an eighteen-foot head.

MORGAN CITY, LA.—B. M. Young and Hugh Young have purchased the electric plant of the Morgan City Improvement Company. They have ordered a new and large first-class plant, complete in every respect, and expect to place it in operation in about four months.

HARRISON, N. J.—Plans are being prepared by the Public Service Corporation for a large electric light and power plant on the site of the old gas works on Passaic avenue, East Newark. The new station is needed to supply the increasing demand for current in West Hudson.

BRIGHTON, COL.—The Northern Colorado Power Company has been granted a franchise to operate an electric plant in Brighton for a period of twenty-five years. This is the initial step in the plans of the company to furnish all towns in northern Colorado with light and power.

GLEASON, TENN.—The stockholders of the Gleason Water and Light Company have elected officers as follows: W. B. Bynum, president; W. H. Williams, general manager, and J. C. Ammons, secretary and treasurer. The general manager was instructed to place an order for the machinery at once.

CANTON, OHIO—Announcement is made by Attorney Thomas F. Turner, president of the Merchants' Heat, Light and Power Company, that a deal has been practically closed by which a large interest in that corporation is to be acquired by capitalists interested in the Stark Electric Railway Company.

ORRVILLE, OHIO—Orrville is to have an all-night electric service in the future. The Orrville Light, Heat and Power Company, J. A. Wagner, of New Philadelphia, chief owner, has been granted a five-year renewal of franchise. The lights are to cost $58 per annum, and new arc lamps will be installed.

PHILADELPHIA, PA.—The electric lighting plants of Manheim and Mount Joy, two towns of 4,000 or 5,000 each, near Lancaster, Pa., have been purchased by C. T. Leland and H. V. H. Stoever, at sheriff's sale for $25,000. They are subject to $43,000 bonds. The companies will be reorganized and the plants improved.

EAST HAMPTON, N. Y.—Stockholders of the East Hampton Electric Light Company have elected directors as follows: Henry A. James, president; George E. Munroe, vice-president; Joseph S. Osborne, secretary and treasurer; Everett Herrick, C. L. W. Eidlitz, S. Minot Jones, B. H. Van Scoy and George A. Eldredge.

LOCKPORT, N. Y.—The town board of the town of Lockport has granted the Economy Light, Fuel and Power Company and the International Power and Transmission Company permission to construct, maintain and operate necessary poles, wires, cables, conduits and other appliances for a transmission line through the town.

PULASKI, N. Y.—The Pulaski board of village trustees has signed a five-year contract with the Pulaski Electric Light and Power Company, whereby the latter will light the streets of the village, providing not less than 121 incandescent lamps, and keep the same burning until 1 A. M., for a sum not exceeding 1,200 per year.

DANSVILLE, N. Y.—The Dansville Gas and Electric Light plant has been purchased by A. B. Beadle, of New York city; W. W. Levering, of Philadelphia, and M. A. Maxwell, of Easton, Pa., and they have taken possession. They purpose expending from $20,000 to $25,000 improving the property and installing new engines and dynamos.

ANNISTON, ALA.—The Coosa River Electric Power Company has closed a deal for the purchase of the Gray lands, which cover over a half-mile of water front on the east bank of the Coosa river in Calhoun county. The lands, with the Randolph lands already acquired, give the company all the property needed for the erection of its dam, power-house and tail-race.

STANDISH, MICH.—The Rifle River Improvement Company is a new corporation organized to furnish electric power for lighting and operating mills and factories at Standish, Bay City, Saginaw and other towns. The dams, it is claimed, will permit the company to generate enough power to operate a belt-line road encircling Arenac county, with headquarters at Standish.

PITTSBURG, PA.—The Kuhn interests, which own and control a number of electric companies and traction systems in Fayette and Westmoreland counties and the coke regions, are planning for the establishment of a central electric plant at New Haven, and will abandon a series of isolated plants in various locations. The company now supplies power and light to several traction systems and a score of small towns.

FOREST GROVE, ORE.—George Bagley, of Hillsboro, has purchased the Dudley mill, northeast of Forest Grove. His object in buying this property is to get possession of the falls on the north fork of Dairy creek. He will deepen the channel and repair the dam, which will furnish power sufficient to operate an electric light plant that he intends establishing to furnish lights for Greenville, Banks, Roy and the surrounding settlement.

SPOKANE, WASH.—The Inland Empire Railway Company has started the development of its power site at Nine Mile bridge on the Spokane river. Sanderson & Porter, of New York city, have been engaged as designing and constructing engineers. The Inland Empire company announces that it will develop 10,000 horse-power at once with facilities for increasing this amount later on to 20,000 horse-power. The plant will cost from $750,000 to $800,000.

CHATTANOOGA, TENN.—C. H. Fisk, manager of the Great Falls Power Company, states that work on his plant will commence not later than August, and when completed will represent an investment of $3,000,000, and develop about 50,000 horse-power. About half of this will be utilized by the electric road running to Nashville and the balance will be brought to Chattanooga for the use of manufacturing concerns which may desire electric power.

ROCHESTER, N. Y.—The board of contract and supply of the city of Rochester, N. Y., has advertised for bids for lighting the streets of the city and the furnishing of electric lamps, care, maintenance and operation of such lamps and appurtenances, including the necessary electricity therefor, for the periods of one, two and five years, respectively, beginning at twelve o'clock, noon, July 1, 1907. Bids must be received at the city hall, Rochester, N. Y., by ten o'clock, A. M., August 22, 1906.

ALBANY, N. Y.—The Port Henry Light and Power Company has been incorporated to carry on operations in the villages of Port Henry, Westport, Elizabethtown, Sand Point and Ticonderoga, and the towns of Moriah, Westport, Elizabethtown, Crown Point, Ticonderoga, North Hudson and Shroon. The capital stock is $100,000, and the directors are: D. A. Foote and John R. Sherman, of Port Henry, and Wallace Murray, T. A. Gould, William Winshull and C. F. Carpenter, of Saranac Lake.

COLORADO SPRINGS, COL.—The Colorado Springs city council has appointed Aldermen Hosman, Holden and Seldomridge, with City Attorney Robinson, a committee to investigate the electric light conditions in other cities, and also the prices charged for light, with a view to taking action on the resolution recently introduced by City Attorney Robinson calling for a reduction by the Colorado Springs Electric Company of its rates from twelve and one-half cents to six cents per kilowatt-hour.

NEWARK, N. J.—At the annual meeting of the Butte Electric and Power Company, held in Newark, N. J., the retiring board of directors was reelected, with the exception that F. Lothrop Ames, of Boston, was elected in place of E. W. Rollins. Copley Amory and S. Z. Mitchell, who were elected during the year past to fill vacancies, were reelected. At the meeting of the stockholders of the four subsidiary companies of the Butte Electric and Power Company the retiring boards were also reelected.

COLORADO SPRINGS, COL.—According to a statement made by G. A. Taff, the first of a series of big power plants which are to be erected by the Empire Water and Power Company will be constructed in Manitou at once. Actual work will begin shortly, and the plant will be rushed to completion. As soon as the demand makes it necessary, a second plant will be installed. The company has almost completed surveys for the reservoirs on its holdings, which comprise 1,000 acres along Crystal and Catamount creeks.

FAYETTEVILLE, TENN.—The board of aldermen of Fayetteville has granted a twenty-year franchise to Fred Eslick, who owns the Brady mill property, near Kelso, and who proposes to cut a canal one-half mile long by which he will be enabled to secure water power sufficient to furnish electric power to illuminate Fayetteville. Work will begin at once, and the current is expected to be ready to be turned on by early fall. The city at present has a lighting contract with the Fayetteviile Electric Light and Power Company.

MUNCIE, IND.—The city of Muncie, having definitely decided to abandon its municipal street-lighting plant because of the expense of operation, and to enter into a contract with a private company to furnish light for the streets, is now receiving bids from electric light companies. Two bids have been received thus far—one from the Muncie Electric Light Company, which agrees to light the entire city at the rate of $57.50 a year for each light for the first 260 lights and $45 a light in excess of 260; the other from the Indiana Traction Company for $65 a year for each light, not less than 260 lights to be used.

DEPEW, N. Y.—The Ontario Power Company has resumed work upon its transmission line in the vicinity of Depew, the work upon which has been at a standstill for several months. The towers are now being erected upon the foundations, which were laid last fall. This is the line which is to supply power to the Lackawanna steel plant. It runs on a line north and south, about half way between the eastern city line of Buffalo and Depew, connecting with the main line, now completed, west of Lockport. It is expected that a wire will be run to Depew and Lancaster to supply power to the various industries at these places.

ALEXANDRIA, VA.—Alexandria, after many years' trial of its municipal electric lighting plant, has finally leased the plant to a private corporation for a term of thirty years. The leasing firm is headed by Edward E. Mandeville, of New York. Mr. Mandeville's contract with the city calls for the payment of $8,500 for the plant and franchise and the furnishing of not less than eighty-five arc lights at an annual cost of $75. This contract calls for a payment to the city of five per cent of the gross receipts instead of taxes. Under the contract Alexandria will pay $20.75 a year more for arc lights than Richmond, which city, under its present contract, pays $54.75 for each lamp. Charlottesville, under the new arrangement with the electric lighting company in that city, is paying $60 a year for each arc light, or $5.25 a year more than Richmond.

ROCKVILLE, CT.—The plant of the Rockville Gas and Electric Company, Prescott Block, Rockville, Ct., has been entirely rebuilt and is operating now under very favorable conditions. There have been installed three thirty-five-light current transformers and a new 150-kilowatt, three-phase, sixty-cycle, 2,300-volt generator. It is expected that by the middle of August the high-tension electric line will be completed from Hartford to Rockville. Over this line the Hartford Electric Light Company is to deliver current to Rockville for lighting the streets, and also for lighting in Stafford Springs. The high-tension current will be transformed at the Rockville plant. When the transmission line is completed the Rockville plant will be held in reserve in case of accident. William M. Lewis is manager of the Rockville Gas and Electric Company.

INDUSTRIAL ITEMS.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., in bulletin No. 1505 describes and illustrates Allis-Chalmers heavy-duty engines, belted type.

JAMES LEFFEL & COMPANY, Springfield, Ohio, have issued a handsome catalogue illustrating and describing their lines of steam engines and boilers. The details of construction are plainly shown and fully explained. This catalogue will be mailed free to those interested, upon request.

THE LINK BELT MACHINERY COMPANY, Chicago, Ill., under its new name, the Link Belt Company, has purchased the plants and all other assets of its associated companies, the Link Belt Engineering Company, Philadelphia, Pa., and the Ewart Manufacturing Company, Indianapolis, Ind.

THE NATIONAL INDIA RUBBER COMPANY, New York city, is now located at 42 Broadway, Le Baron C. Colt, agent. The company is represented by Henry D. Stanley in the rubber-insulated wire and cable department, and by Henry D. Archer in the department for druggists' sundries, hose, packing and clothing.

THE A. L. SWETT ELECTRIC LIGHT AND POWER COMPANY, Medina, N. Y., has published an illustrated description of the power equipment at Medina. This is a very interesting story, and is devoted principally to calling the attention of business men to this enterprise and to the advantages of Medina as a location for manufacturing industries.

THE ARROWSMITH ELECTRIC COMPANY, 434 Market street, Harrisburg, Pa., announces the withdrawal from the company of A. V. Arrowsmith, formerly vice-president and general manager. The company will continue in business at Harrisburg and Reading, under the management of John S. Musser, who reports a very satisfactory state of trade.

THE H. C. ROBERTS ELECTRIC SUPPLY COMPANY, Syracuse, N. Y., is making use of an elaborate automatic telephone card index as a business souvenir. This card index contains sufficient space to insert 170 names, alphabetically arranged. The index case is made of aluminum and weighs, with the cards, about four ounces. The index is made by the Automatic Card Index Company, Utica, N. Y.

THE HOLSCHER ELECTRIC MANUFACTURING COMPANY, Warren, Ohio, is now under the management of M. Kecklinger, who has taken charge since the death of C. Holscher, some sixty days ago. The company manufactures incandescent lamps, and advises that it is operating entirely independent of any organization agreements. Manager Kecklinger mentioned that the company is looking for larger quarters and may move later in the season.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., will be pleased to send the August issue of "Graphite" to any one interested in this material. This issue contains the usual interesting literature pertaining to the applications of graphite. The company will be pleased to send to any one interested, upon request, a folder describing Dixon's graphite brushes. In addition to the descriptive matter there is a report of tests made upon these brushes.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York, N. Y., will shortly issue an attractive catalogue showing a complete line of "J.M." asbestos packings, copies of which will be mailed upon request. These packings do not contain rubber or organic material, will withstand any temperature or pressure, are pliable and readily conform to irregular surfaces. The company has achieved great success with this line of steam packings.

THE C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y., will be pleased to send its new bulletin descriptive of Hunt industrial railways to any one interested, upon request. The company announces that for repairs required or for emergencies arising after business hours or on holidays, the following may be called up on the local or long-distance telephone at any hour: D. H. Gildersleeve, sales manager, telephone number 134 L. West New Brighton, N. Y.; J. W. Eckert, superintendent, telephone number 64 J. West New Brighton, N. Y.; C. M. Steinrock, traffic manager, telephone number 89 J. West New Brighton, N. Y.

THE DE LA VERGNE MACHINE COMPANY, New York, N. Y., reports the following recent orders for "Hornsby-Akroyd" oil engines: Wheaton Seminary, Norton, Mass., thirteen horse-power; Rahr Brewing Company, Oshkosh, Wis., thirty-two horse-power; Vitagraph Company, Brooklyn, twenty-five horse-power; Regal Oil and Gas Company, Chicago, Ill., sixty-five horse-power; L. R. Wright, Pecos, Tex., thirteen horse-power; Jas. H. Holden, Fall River, Mass., seventy-five horse-power; borough of Souderton, Souderton, Pa., fifty horse-power; James L. Breeze, Southampton, L. I., thirty-five horse-power, direct-connected to twenty-five-kilowatt generator.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., announces that Captain I. N. Lewis, Artillery Corps, U. S. A., will call at its factory during August "on official business pertaining to the installation and operation of electrical machines, tools and power transmission machinery, and for the purpose of securing special information concerning electrical and laboratory apparatus and power-plant equipment." This unsolicited call upon the Crocker-Wheeler Company indicates the government's high opinion of the company's electrical engineers, whose skill in laying out for the government systems for generating and supplying electrical power is constantly in demand.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has issued a new series of literature. An attractive blotter calls attention to mercury arc rectifiers for battery-charging panels. Flier No. 2192 describes and illustrates motor-starting rheostats with no-voltage release, type SA. A new folder calls attention to the many types of bases for Edison standard lamps. Bulletins Nos. 4443, 4446, 4447, 4449 and 4450 describe and illustrate, respectively, the following apparatus: Sprague-General Electric multiple-unit control for alternating and direct-current operation; starting compensators for alternating-current motors; low-voltage, three-phase generator and feeder panels; potential and synchronizing plug switches; parts of GE-80-A railway motors.

THE BRILLIANT ELECTRIC COMPANY, Cleveland, Ohio, has opened a special department to take care of the demand for Brilliant "Gem" and Brilliant tantalum lamps. While this department will be under the management of E. J. Kulas, the general manager of the company, it will be submanaged by E. V. Hennecke, who will cover a large part of the country exploiting these lamps. An illuminating engineering department has been installed for the purpose of assisting patrons in the design and construction of illuminating schemes. This service is entirely free, and the company invites requests for suggestions. The demand for the Brilliant tantalum lamp, the company announces, has been beyond all expectations, and it is in view of this demand and the desire to handle its customers' wants to the best advantage that the company has opened this department, at a considerable outlay.

THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., announces that the recent fire at its Oakland (Cal.) factory did not affect the engine and boiler house, and that the insulating tanks and drying ovens are intact. The company was fortunate in having a new lead press and steam pump *en route* from the East, and it is expected that temporary repairs will be made at once and that the lead-covering department will be in operation within about a week. Meanwhile temporary buildings are being erected for the storage of new stock, and the company is prepared to handle orders practically without delay, as a large shipment of new stock has been made to Oakland. The company will reestablish a San Francisco office at 332 Bush street for the convenience of its San Francisco patrons. At the present time, however, the main Pacific coast office will be continued in the Bacon Block, Oakland, Cal.